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THE ESTABLISHMENT OF A MANAGEMENT
INFORMATION SYSTEMS RESEARCH CENTER
AT THE NAVAL POSTGRADUATE SCHOOL

by

John F. Feiler

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Thesis Advisor:

Tarek K. Abdel-Hamid

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The Establishment of a Management Information Systems Research Center
at the Naval Postgraduate School

by

John F. Feiler
Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1977

Submitted in partial fulfillment of the requirements for
the degree of

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from the

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September 1989

ABSTRACT

This thesis investigates the opportunity for the establishment of a Management Information Systems research center at the Naval Postgraduate School and the unique purpose it would serve within the Department of Defense community. Following the analysis of five existing information systems research centers and their various objectives and activities, pertinent issues regarding the Naval Postgraduate School are identified through interviews of relevant faculty and staff. A mission is identified for a Naval Postgraduate School "Information Systems Research Center", and a strategy involving the center's objectives and activities is suggested.

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I. INTRODUCTION

Information systems research centers are research organizations established within the MIS departments of academic institutions to facilitate and enhance the conducting of research in the MIS field. They are typically staffed by faculty, students and other research talent, and who in most cases work in partnership with sponsoring organizations. Sponsoring organizations are combinations of businesses, government affiliates, and funding agencies. [Ref. 1,2,3] The relationship between the various components is depicted in Figure 1. To IS research centers, MIS research is the primary objective. A 1985 survey of ten existing IS research centers noted that one objective which was common to all of them was that of the "...[performance of] research into the development, implementation, and utilization of information systems in organizations." [Ref. 2] (For a partial list of IS research centers, including those surveyed, see Table 1.)

For this thesis, five well established IS research centers (in varying degrees of component relationships) were used as sources for comparative purposes. All IS research centers studied tend to establish for themselves a mixture of objectives (See Table 2). These objectives, in turn, affect the interaction among the various constituents, and "these relationships thus determine the nature of [the centers'] research and activities." [Ref. 2]

IS research centers strive to attain their established objectives by conducting a variety of activities. For example, maintaining a working paper series and the sponsoring of conferences are activities which can be undertaken to "disseminate significant research findings to the MIS community." [Ref. 2] Additional activities are listed in Table 3.

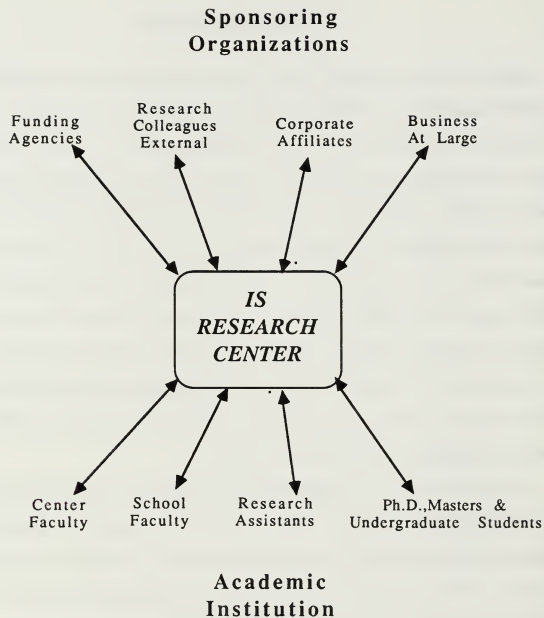


Figure 1 Component Relationships of an IS Research Center

Source: [Ref. 4]

TABLE 1

EXISTING IS RESEARCH CENTERS [Ref. 1, 2, 3]

University of Minnesota
Massachusetts Institute of Technology
University of Houston
Rice University
New York University
University of California, Los Angeles
University of Michigan
University of South Carolina
Boston University
University of Arizona
University of Georgia
University of South Florida
Rockhurst College
Washington University
Illinois Institute of Technology
Babson College
University of North Texas
University of Pennsylvania
Indiana University
Pennsylvania State University
Boston College

Various sources agree that the existing IS research centers not only perform valuable functions, but they also help to gain valuable benefits for the academic institutions, the IS professionals, and the sponsoring organizations who utilize them [Ref. 1,2,3]. With respect to academic institutions, an IS research center can enhance both the quality and currency of the academic programs. Such curricular improvements are generally achieved through interactions between the IS research centers' participants which include the schools' students and faculty, as well as the research staffs and the sponsoring organizations. Their combined interaction results in significant increased awareness of existing IS issues. [Ref. 2]

Sponsoring organizations can also provide valuable material for developing case studies for IS classes. In addition, they can serve as field study sites for course

TABLE 2
IS RESEARCH CENTER OBJECTIVES

<u>Institution</u>	<u>IS Research Center</u>
University of Minnesota	MISRC (Management I S Research Center)
MIT	CISR (Center for Information Systems Research)
University of Arizona	CMI (Center for the Management of Information)
New York University	CRIS (Center for Research on Information Systems)
University of Georgia	EUCRC (End User Computing Research Center)

	1	2	3	4	5	6	7
MISRC	X	X	X				
CISR	X	X		X	X	X	
CMI	X	X		X	X		X
CRIS	X	X		X	X		X
EUCRC	X	X	X		X		

Objectives

- 1) Perform research into the development, implementation, and utilization of IS in organizations.
- 2) Promote interaction among MIS professionals and academicians.
- 3) Educate, develop, and train MIS professionals and educators.
- 4) Provide research environment for students and class projects.
- 5) Disseminate significant research findings to the MIS community.
- 6) Expand financial support for MIS research at the university.
- 7) Develop research projects to attract top MIS faculty.

Source: [Ref. 1,2,3]

TABLE 3

IS RESEARCH CENTER ACTIVITIES

<u>Institution</u>	<u>IS Research Center</u>
University of Minnesota	MISRC (Management I S Research Center)
MIT	CISR (Center for Information Systems Research)
University of Arizona	CMI (Center for the Management of Information)
New York University	CRIS (Center for Research on Information Systems)
University of Georgia	EUCRC (End User Computing Research Center)

	1	2	3	4		6	7	8
MISRC	X	X	X	X	X	X	X	
CISR	X	X	X	X		X		X
CMI	X	X	X	X				X
CRIS	X	X	X					
EUCRC	X	X	X	X		X		

Research Center Activities

- 1) Programs, workshops, symposiums
- 2) Sponsored research projects
- 3) Working paper series
- 4) Student projects, internships
- 5) Information/job clearing house
- 6) Training programs, development
- 7) Resume book, career fairs
- 8) Consulting

Source: [Ref. 1,2,3]

projects. Valuable experience can be gained by the students' interacting with their sponsoring organization's personnel. Additionally, possible thesis or dissertation topics can be derived from such participation. These valued interactions enhance the relevancy and currency of what students are taught in the classroom. [Ref. 2]

A further benefit to the academic institution provided by an IS research center is a "concentration of resources". Normally, institution funding for research is not adequate. Likewise, a researcher may be limited to one problem, one approach, and supported by only one sponsor. Further diluting the research environment is the number of contacts a single researcher can manage. Without the involvement of a research center, contributions through research are largely determined "on a piecemeal basis by the researcher at professional meetings, through consulting, or simply by chance." Again, an IS research center averts this problem through the interaction it encourages and the potential funding sources it attracts. [Ref. 2]

The academic institution and its researchers and students are not the only beneficiaries of an IS research center. Its objectives and many possible activities often support the sponsoring organizations. Sponsoring organizations become the focus of the applied research, benefitting not only the organization, but also the entire IS field. Each IS research center "focuses its efforts on unique research projects, bringing its individual talents and cultures to bear on the problems of IS and business." [Ref. 3] Additional research center activities that organizations take advantage of include consultation relating to IS management and technical problems, assistance in developing in-house training programs, and clearinghouse activity for information on specific IS issues. Furthermore, the IS research center function is a vehicle for the continuing education and, in some cases, training for an organization's IS professionals. Along with the directed research efforts, the variety

of methods of disseminating research results facilitated by the IS research centers (e.g. symposiums, lecture programs, working paper series, etc.) ensures that the opportunity for the IS professional to remain aware of current research efforts will continue. [Ref. 2]

To assist in the analysis of the various approaches used for existing IS research centers, a framework was developed. This IS research center framework includes each of the following elements; theme, organization, and funding. Sub-elements are included within each element. For purposes of demonstration, the five previously compared IS research centers will again be referenced as examples in Table 4. (More detailed information on each of the five IS research centers is provided in Appendix B.)

An IS research center's theme may have a very strong focus that encourages a concentration on a single area of interest. An example of such an approach is the center at the University of Georgia. In an attempt "to address important end user computing issues", the End User Computing Research Center (EUCRC) was established [5]. Some IS research centers on the other hand may state a theme that is broader in scope, incorporating numerous IS areas of interest rather than one or a few specific areas.

MIT's Center for Information Systems Research (CISR), for example, focuses on managerial issues relating to IS. However, as it is further defined in the center's annual report, CISR "assists in defining and investigating research on fundamental issues affecting the public and private sectors in such areas as: managerial use of computers; information technology; the management of the information systems function; and the impacts of information systems on organizations." [Ref. 6]

TABLE 4
FRAMEWORK OF ACADEMIC RESEARCH CENTERS

CENTER	THEME		ORGANIZATION				FUNDING				
	interest areas		faculty preference	research	clerical existing		grants	projects		sponsor dues	school support
one	variety	only			faculty	research center		faculty raised			
MISRC			X		X				X	X	@
EUORC	X			X	X		X	X			@@
CISR		X		X			X	X		X	
CMI		X		X		X	X	X			X
CRIS			X			X	X		X		X

@ -release time for director
 @ -release time for faculty
 -high quality office space
 -computer facilities support

Although CISR maintains a central theme, it nonetheless entertains a variety of IS interest areas that easily fit within its scope. University of Arizona's Center for the Management of Information (CMI) likewise entertains a variety of IS interest areas despite emphasizing "rigorous technical IS design and application." [Ref. 7, 8] New York University's Center for Research of Information Systems (CRIS) claims to have no theme. The center's research mission is stated as "...a vehicle for serving the faculty on a broad spectrum of research projects." [Ref. 4] Therefore the IS interest areas vary as much as do the faculty's interests.

If an IS research center's theme has a "strong" focus, it tends to narrow the number of interest areas to which particular IS issues (and organizational concerns) may apply. A theme of a broader nature yields additional areas for specific research interests, and still provides a perspective that helps determine whether the projects or IS issues can be addressed by a particular IS research center. The lack of a theme leaves the field wide open to any number of areas while the focus shifts to a more supportive role of the faculty. This leaves some question as to the continuity of the IS research center's interest areas or whether some issues will be addressed at all. NYU's CRIS admits a "constant tension" in their attempt to match requests from their affiliate organizations [Ref. 4]. To some extent then the interest areas are left to the desires of the sponsoring organizations.

The second element of the IS research center framework considers who should head the center and how it should be staffed. Electing a director is most important. The initial establishment of an IS research center is somewhat dependent on the director's ability to contribute a "concentrated effort" for a period typically exceeding a year [Ref. 3,9]. In addition to the director, some centers maintain an extensive research staff while other centers are skeletal, and barely clerical in nature. CISR's

staff is considered extensive. In fact it maintains two staffs. Its "core staff" consists of the MIS faculty and "several full-time research associates." CISR's director and associate director are assisted by the second staff which is more administrative in nature and consists of a business manager as well as an administrative secretary. [Ref. 6] At the other extreme is New York University's CRIS. The center's staff is maintained to be as small as possible. Its director "...acts more as a facilitator in obtaining needed resources..."; however, no staff assistance is provided to the faculty members for the administration of their projects or for the management of their projects' budgets. [Ref. 9]

Most IS research centers include some or all of an academic institution's MIS faculty. As projects are increasingly determined by the desires of the faculty, there is less of a need for a research staff to guide and administer the projects. Essentially, the faculty conduct their own projects with the assistance of the IS research center staff, if needed. As an IS research theme becomes more of a factor, and the interest areas are reduced in number from "laissez-faire" to a narrower theme, a single faculty member's wide interests are narrowed somewhat. Of course with time, projects tend to increase in size and complexity, requiring an increasing interaction among personnel, other faculty, disciplines, organizations and IS professionals, increasing the need for assistance of a staff in managing portions of that interaction, while at the same time facilitating it.

The final framework element is funding. Funding can extend from two sources; the school and/or organizational sponsors. In the majority of cases any funding by the academic institutions is limited; and if it exists at all it is usually in an indirect manner such as through course instruction release time, or the maintaining of facilities used by the IS research center related personnel. The Management

Information Systems Research Center (MISRC) is supported by the University of Minnesota only in terms of partial course release time for the center's director and "...high quality office space for MISRC personnel." [Ref. 10] Georgia's EUCRC provides course release time for the involved faculty as well as the director. The university also provides support for the mainframe computer that serves as the host for the EUCRC's PC laboratories. [Ref. 5]

Funding by sponsors is received primarily in three methods. The first method is the awarding of an out right grant to the research center by an organizational sponsor for its distribution among researchers, for the various research needs (i.e., personnel, supplies, equipment, etc.). Georgia's EUCRC received such a grant to begin its center's operations in the support of "...research and education in end user computing." [Ref. 5] The second method of funding usually targets a specific IS issue or interest area. The funds are provided to the research center for their proper distribution within that area; or the sponsor grants the funds to a faculty member whose efforts persuaded the organization to fund a project that is in that organization's best interest. A major activity of some IS research centers is to assist the school's faculty members in acquiring such funds, instead of searching for research opportunities and subsequent funding for the center itself. New York University's CRIS assists the faculty members in their endeavor to raise research funds by "...getting [them] through the bureaucratic maze of project funding...", and maintaining strong ties with sponsoring organizations. [Ref. 4]

The final method of sponsored funding is usually in the form of an association dues or contributions on a scheduled periodic basis. Funding for the operations of MISRC at the University of Minnesota is almost wholly generated from the annual fee collected from the 20 organizations who are "associates" of the center. [Ref. 10]

The IS research center at MIT's Sloan School of Management also receives some funding of this type. The center's annual report reveals that, "...a limited number of [sponsoring] organizations contribute to the unrestricted support of CISR on an annual basis." [Ref. 6]

Funding is a necessary element of research. Someone or some group must attract those funds. If an IS research center is not in some way instrumental in attracting the needed funds, then it is left up to the sole efforts of the researcher. Valuable time and effort are shifted from the project, its planning and pertinent research, to the activity of persuasion in the acquiring of additional resources. At the very least, an IS research center ensures that the channels of communication remain open to those organizations that do now, or may soon fund research projects. Additionally, it can provide the needed credibility and clout to those individuals seeking research partnership with sponsoring organizations.

II. TWO IS RESEARCH CENTERS: AN IN-DEPTH LOOK

A more in-depth example of the framework described in the previous chapter will be provided by comparing two well recognized and successful IS research centers; University of Minnesota's MISRC and MIT's CISR.

A. MISRC

No one theme is dominant at MISRC. In fact the center does not even entertain nor suggest one. This approach is supported by the MISRC emphasis that the center does not perform research. "The prime function of the center is to support research." All research by the faculty "...is determined to a very large degree by individual interests and talents." One emphasis of the center is, however, an involvement in the education and training of educators and MIS professionals; and in this supporting role the center seems to have positioned itself appropriately to further that objective in concert with the school's faculty. [Ref. 10]

The organization at Minnesota's MISRC consists of a minimal staff. There are only two permanent clerical personnel and no permanent research staff. This is in keeping with their objective of serving as a support mechanism for research rather than performing research. Two graduate assistants provide additional support on a part time basis. As is typically the case there is a director; however, he receives course release only part of the time. The involvement of additional faculty is neither enforced nor limited. "A faculty member can have as much association with the research center or as little as suits their individual needs." [Ref. 10]

For faculty members associated with the MISRC, the center performs a number of functions. For example, the center attempts "...to find sites or subjects in

Associate firms for an MIS faculty member or doctoral student who needs these in association with planned research." (See Table 5.) The center will also "hold and disperse" research funds acquired by the faculty member from their project sponsors. If in proper clerical form, MISRC will print a faculty member's paper for distribution at no cost to the member. (See Table 6.) One of the more unusual support methods provided by MISRC is a "Line of Credit". "Any MIS faculty member can request up to \$2,500 to be spent for any purpose." \$2,500 is also the credit limit; therefore, a faculty member may not amass more than that amount. MISRC is reimbursed by the various articles the borrowing member publishes. The "pay back" per article can vary, depending on which journals publish them, between \$100 and \$500. [Ref. 10]

The source of funds for operating the MISRC is not derived from projects obtained by faculty or sponsored by organizations. Based on one of its original concepts that the center will facilitate "...a partnership between local industry and the university...", MISRC collects a fee annually from organizations that are deemed "associates" of the research center. (See Table 7.) Currently, there are 20 associates whose support has helped fund MISRC operations. Assistance from the university is limited and apart from the part time course release for the director, it consists only of office space for research center personnel, and the use of some facilities. [Ref. 10]

Along with defraying the costs of operating MISRC, the remaining funds result in research center activities such as the dissemination of research findings through support of a working paper series. "One of the major activities of the center is to provide funding organizations with a very high quality speakers program." The

TABLE 5

MISRC RESEARCH PROJECTS IN PROGRESS

<u>Project Title</u>	<u>Participants</u>	<u>Funding</u>
Management of Information Systems	T. Hoffmann G. Dickson G. Davis J. Wetherbe	IBM
The Knowledge Interview Subject System Project	D. Naumann C. Beath R. Ye M. Alanis	IBM
The Use of Information Technology for Competitive Advantage in New Business Venture: A Contingency Approach	R. Cardozo V. Sambamurthy	IBM
Group Decision Support Systems	G. DeSanctis M. Poole G. Dickson R. Watson I. Zigurs V. Sambamurthy	IBM
Group Decision Making and Group Decision Support Systems	G. DeSanctis M. Poole	National Science Foundation
Data Resource Management Roles and Responsibilities: Exploratory Studies	D. Goodhue M. Wybo	IBM, University of Minnesota
In-Context Assessment of Information Systems	G. Davis	IBM
The Planning and Development of a Model Academic Integrated Information Center	C. Beath G. D'Elia D. Straub	Council of Library Resources

Source: [Ref. 10]

TABLE 6
MISRC WORKING PAPER SERIES: A SAMPLE

<u>No.</u>	<u>Title</u>	<u>Authors</u>
WP 88-01	Positioning Computer Security in the Organization	D. Straub
WP 88-02	Group Decision Making and Group Decision Support Systems: for the GDSS Research Project	M. Poole G. DeSanctis
WP 88-03	GDSS Technology in Practice: A Study	D. Straub R. Beauclair
WP 88-04	Interaction Analysis in GDSS Research: Description of an Experience and Some Recommendations	I. Zigurs
WP 88-05	Business Graphics Trends: Two Years Later	J. Lehmann V. Sasmbamurthy
WP 88-06	A Conceptual Framework for Studying Systems Innovations	D. Straub
WP 88-07	A Study of Influence in Computer-Mediated Decision Making	I. Zigurs M. Poole G. DeSanctis
WP 88-08	End-User Computing and Knowledge Work: Managing the Introduction of New Information Technology	J. Brancheau J. Wetherbe
WP 88-09	Testing and Extending Innovation of Diffusion Theory in the Context of End-User Computing	J. Brancheau J. Wetherbe
WP 88-10	Computer Fraud Against Organizations	D. Straub M. Wybo
WP 88-11	An Investigation into the Use and Usefulness of Security Software in Detecting Computer Abuse	W. Nance D. Straub
WP 88-12	Mechanisms for Facilitating Managerial Interactions in Information Technology Planning: Directions for Research	V. Sambamurthy G. DeSanctis

Source: [Ref. 10]

TABLE 7

MISRC ASSOCIATE COMPANIES 1987-1988

AT&T	Minnesota Mutual Life
Burlington Northern	3M
Cargill, Incorporated	National Car Rental Systems, Inc.
Cenex	Northern States Power Company
Control Data Corporation	Norwest Technical Services, Inc.
Ecolab	Onan Corporation
General Mills, Inc.	The Pillsbury Company
Honeywell Inc.	The St. Paul Companies, Inc.
IDS Financial Services	Star Tribune
International Multifoods	State of Minnesota
Lutheran Brotherhood	The Toro Company
Medtronic, Inc.	

Source: [Ref. 10]

program is typically followed up with a research workshop for the doctoral students and MIS faculty and, if possible, also includes the speaker. [Ref. 10]

Although MISRC has no specific theme, it certainly strives for its objective as a "support mechanism for MIS research". The primary means it accomplishes this objective is by the center's efforts to maintain a strong link with local organizations. In this capacity and with the "associate" funding, the center effectively utilizes its minimal staff and its faculty to carry out its functions while producing some valuable research activities. There success in this endeavor only strengthens that link. [Ref. 10]

B. CISR

Unlike MISRC, MIT's CISR does have a theme which encompasses a variety of interest areas. Stated simply, its broad-based theme is to "...work on major problem-centered research issues of interest to both faculty and practitioners in the [IS] field." [Ref. 9] More specifically, CISR has focused on "...the importance of the use of computer-based systems by managers." One of the subsequent objectives is to conduct IS research that is "managerially relevant". The resulting interest areas span the entire IS field. They can be generally categorized into the following groups:

- The managerial use of computers and computer-based information.
- Understanding key information technologies.
- The management of the information systems function.
- The impact of information technology on organizations.

A few examples of some of the unique areas that are easily categorized here (but otherwise slated under "Other Issues" of the interest areas of Table 4) include; executive support systems, artificial intelligence, composite information systems (interorganizational systems), information systems measurement and impact. [Ref. 6]

The staff at CISR is considered to be extensive, and in fact, the center maintains two of them; a "core staff" and an administrative staff. Included in the core staff are MIS faculty as well as "several full-time research associates". This staff is particularly beneficial to the research teams that are encouraged at CISR. This eclectic approach is a means to focus academic disciplines, technical fields, and business needs to keep "...the research focused on issues of effectiveness."

Normally the research design is conducted by the faculty while the management of the projects is the responsibility of the research staff. Student participation also includes, but is not limited to the data gathering analysis. [Ref. 6]

"CISR's administrative and support staff coordinates the operations of the central CISR office, manages [the] various seminars, and is responsible for CISR publications." The administrative staff includes a business manager, and an administrative secretary (who supports CISR's director and associate director). The final member of the administrative staff, the senior office assistant, is responsible for the distribution of the working paper series. [Ref. 6]

The "critical source" of funding for CISR is provided by "Participating Sponsors"; an impressive list of some of America's most recognized and respected corporations. (See Table 8.) "A CISR Participating Sponsor is a substantial user of computer-based information systems and is in agreement with the objectives, goals, philosophy and overall research program of the Center." These sponsoring organizations not only contribute financially, but also provide sites for useful research, release employees to serve as research center "fellows", and engage in the exchange of ideas and viewpoints related to areas of interest and concern within the IS field. [Ref. 6]

The sponsors are also active participants in what is recognized as the most extensive program of seminars for both educators and MIS managers. They include: an annual, four day summer conference "...where practitioners and researchers can discuss significant issues in management of the information systems function"; a series of two and one-half day seminars that "...focus on actual practice presented by sponsors and others in case studies of current efforts"; and a few one-day seminars each year "...to give the participants in-depth exposure to both new and

TABLE 8
CISR PARTICIPANTS SPONSORS

American Express Travel Related Services Company
 Amoco Corporation
 ARCO Chemical Company
 Arthur Andersen & Company
 Bank of Montreal
 Baxter Healthcare Corporation
 Chemical Bank
 Digital Equipment Corporation
 E.I. Du Pont de Nemours and Company
 Eastman Kodak Company
 Electronic Data Systems
 Exxon Corporation
 Firestone Tire & Rubber Company
 Honeywell, Inc.
 IBM Corporation
 Index Group, Inc.
 Internal Revenue Service
 Johnson & Johnson
 Mars, Inc.
 Martin Marietta Data Systems
 Proctor & Gamble Company
 Sara Lee Corporation
 Sun Company
 Texas Instruments, Inc.
 Xerox Corporation

Source: [Ref. 6]

ongoing research." Having not quite the scope of a seminar, but bearing some importance for CISR's research process, "special interest group" meetings are held periodically "...to facilitate discussion among a small group of managers who are actively working on a particular issue." In addition to providing another source of funding, the seminars also serve to disseminate CISR research findings, as does the working paper series. [Ref. 6] (See Table 9.)

Through its extensive activities CISR maintains a close rapport with its intensive organizational sponsors. For their generous participation, the sponsoring

TABLE 9

CISR WORKING PAPER SERIES: SOME RECENT ARTICLES

<u>No.</u>	<u>Title</u>	<u>Author(s)</u>
150	Managing the Data Resource: A Contingency Perspective	D. Goodhue J. Quillard J. Rockart
151	The Economics of Software Quality Assurance: A System Dynamics Based Simulation Approach	T. Abdel-Hamid S. Madnick
152	An Integrative System Dynamics Perspective of Software Project Management: Arguments for an Alternative Research Paradigm	T. Abdel-Hamid S. Madnick
153	Finding Synergy Between Decision Support Systems and Expert Systems Research	J. Henderson
154	Information Technology Impacts on Innovation	S. Lee M. Treacy
155	User Approaches to Computer-Supported Teams	R. Johansen
156	Information Technology Impacts on Power and Influence	S. Lee M. Treacy
157	Data Envelopment Analysis for Managerial Control and Diagnosis	Epstein J. Henderson
158	Managing the I/S Design Environment: A Research Framework	J. Henderson
159	The Impact of Information Technology on Control: A Leadership Theory Perspective	S. Lee M. Treacy
160	The Line Takes the Leadership	J. Rockart
161	Dependent Variables for the Study of Firm and Industry-Level Impacts of Information Technology	Bakos
162	Information Technology and the Structuring Process	S. Lee D. Robertson

TABLE 9 (CONTINUED)

163	Modeling the Dynamics of Software Project Management	T. Abdel-Hamid S. Madnick
164	Cooperative Behavior in Information Systems Project Management	J. Henderson
165	Information Technology and Work Organization	K. Crowston T. Malone
166	The Realities of Electronic Data Interchange: How Much Competitive Advantage?	R. Benjamin D. De Long M. Scott Morton
167	Scale Economics in New Software Development	R. Banker C. Kemerer
168	Software Production Economics: Theoretical Models and Practical Tools	C. Kemerer
169	Groupware: A Key to Managing Business Teams?	C. Bullen E. Johansen
170	Evolution Towards Strategic Applications of Databases Through Composite Information Systems	S. Madnick Y. Wang

Source: [Ref. 6]

organizations are benefactors of CISR's "extensive research" of IS issues, often related to organizational concerns. The relatively large staffs provide effective assistance in managing and disseminating CISR research. To date, CISR has accomplished its mission "...to bring a broad range of disciplines and input from industry to bear on critical questions concerning how managers can take advantage of continuing advances in the information systems field." [Ref. 6]

Inferred by existing literature and exemplified by the two previous cases, the inception of IS research centers has resulted in a favorable relationship between IS user organizations and academic institutions. IS professionals and their organizations remain cognizant of research efforts and current findings. The universities benefit from the continuing efforts of the IS research centers that "...ensure the proliferation of academic insight and scientific understanding of the growing IS field." [Ref. 3] By meeting their objectives IS research centers will have accomplished their primary goal, that being "...to link their school's faculty and programs with the IS community they serve." [Ref. 1]

III. INVESTIGATING THE ESTABLISHMENT OF AN MIS RESEARCH CENTER AT NPS: A SURVEY OF OPINIONS

A. INTERVIEWS

Material regarding the existing IS research centers referred to in this thesis was obtained through literature review that included annual reports and published articles. To gain some insight on the feasibility of establishing an IS research center at the Naval Postgraduate School (NPS), a series of interviews was conducted with certain NPS faculty and staff in an attempt to obtain an initial perspective of the pertinent issues. A semi-structured format used as a guide for the interviews is shown in Figure 3.

With respect to the establishment of an IS research center, the following issues were the primary focus of the interviews: (1) the role or mission; (2) organization; (3) funding; (4) activities-special considerations. With a focus on these preceding issues, a group of the faculty and staff having some insightful and relevant information was selected.

Beginning with the current Director of Research at NPS, Professor Howard was selected to provide information on the current system for attracting and funding research, as well as the potential problems, conflicts, and politics involved once a research center is established. Professor Liao also has significant input to the school's research assignments and is most knowledgeable concerning the relationships with research sponsors in the Administrative Sciences Department at NPS. His expertise was thought valuable for questions related specifically to funding issues. Professor Whipple is the current chairman of the Administrative

Sciences Department (of which all MIS faculty are a part). His thoughts concerning an IS research center's role and potential benefits with respect to the current IS curriculum, in addition to possible conflicts, were deemed valuable.

Mission:

- projected
- themes
- interest areas

Organization:

- director
 - teaching load
 - potential conflicts
- staff
 - faculty
 - graduate students
 - clerical

Funding:

- types
- sources
- limits
- considerations

Goals:

- objectives
- advantages/benefits
- disadvantages

Outputs:

- activities
 - types
 - considerations
- dissemination of findings

Figure 3 Semi-structured Interview Guide

An interview with a former Administrative Sciences Department chairman, Professor Jones, was helpful in comparing the perspectives of former and current chairmen. Additional suggestions were expected from Professor Schneidewind's experiences with the establishment of a research consortium. As Associate Chairman for Instruction of MIS, Professor Dolk was expected to provide beneficial information pertaining to the IS graduate students' current, and potentially more efficient, involvement in the research process. Having previously interviewed the school's MIS faculty, and because of his initial involvement in the establishment of an IS research center, it was thought potentially valuable to obtain Professor Haga's thoughts and interpretations pertaining to his initial findings. A complete list of those interviewed is contained in Table 10.

TABLE 10

INTERVIEWS FOR DISCUSSION OF IS RESEARCH CENTER

<u>Date</u> (89)	<u>Name</u> (alphabetical)	<u>Position</u>
Apr 5	Daniel R. Dolk, Professor of MIS	Associate Chair for Instruction Department of Administrative Science
Feb 28	William J. Haga, Adjunct Professor of MIS	Department of Administrative Science
Apr 24	Gilbert T. Howard, Professor of Operations Research	Director of Research Administrative Staff
Apr 26	Carl R. Jones, Professor of Information and Telecommunications Systems	Chairman for Joint C3 (former Admin Science Chair)
Mar 21 May 8	Shu Liao, Professor of Accounting	Associate Chair for Research Department of Administrative Science
Apr 4	Norman F. Schneidewind Professor of MIS	Department of Administrative Science
May 10	David R. Whipple, Professor of MIS	Chairman Department of Administrative Science

Of initial interest was each interviewee's general impression and reaction toward the possible establishment of an IS research center. Of specific interest was whether the participants could foresee any potential conflicts that might arise between the IS research center (whose established members would be primarily of the Administrative Sciences Department) and other departments. Almost all of those interviewed responded favorably. All participants either suggested or understood that the center would need a director, and yet no one interviewed could initially conceive of why a research center or its figurehead might lead to conflicts with any currently existing positions or departments.

B. FRAMEWORK

1. Mission and Purpose

Although the idea of an IS research center was generally well received, two less favorable responses focused on doubts concerning the purpose of such a center. "It should avoid being just a facade", was one reply. The professor continued to explain that there are a limited amount of resources, not the least of which are time and manpower, and cooperative efforts present some difficulties in having people work effectively together, due to the individual faculty member's different interest areas. If the faculty wishes to create outside interest or invite interaction, then rather than establishing a research center for its own justification, the faculty "...should not overlook the benefits of getting involved outside of the Naval Postgraduate School" [with institutions and professional associations]. [Ref. 11]

Similarly skeptical of underlying motives another interviewee stated, "There is nothing to prevent anyone from hanging a shingle and calling it anything you want as long as [NPS] commitments are maintained". Further comment indicated a

wariness of possible "research empires" which are not typically set up with the students' best interests in mind; noting the primary purpose at NPS is teaching. [Ref. 12]

The commitment to NPS and its students seemed to be well understood by all faculty who participated in this study however. Well aware that teaching is the first and foremost purpose underlying the mission of the Naval Postgraduate School, a typical response from the remaining participants consistently repeated the fact that any efforts to establish an IS research center would "...have to be commensurate with the mission of NPS." [Ref. 13] As for encouraging outside interest and interaction among organizations and other institutions impacted by the IS field, that is one of the most beneficial functions (if not the underlying goal) of a research center. To leave the creation of such to the preferences of one or a few individuals would seem to be inviting one's biases and possible self interests over the combined benefits for the IS faculty and students. Assuredly, this type of action would not be purposeful; however, like one's time and resources, so are one's contacts limited. A research center could not only encourage more involvement and interaction with outside organizations, but because of its more directed and synergistic efforts, it could also have a potentially greater scope and a less limited focus than that of a few individuals of totally diversified and disassociated efforts.

Additional objectives were forthcoming from the interview participants, one of which suggested a more interactive type of role. "There are numerous Department of Defense activities with small problems, limited resources, and no money." Another statement dictating the plight of many DoD activities followed; "They know they need help [with IS], but instead things just go undone." [Ref. 14] Currently, there are two methods by which most "needy" activities become informed

about NPS's IS resources. They either "find us" because one of their personnel had a previous assignment to NPS, or as was adequately stated, "...someone hears of us through the grapevine." There is no current research function to coordinate the guiding of outside DoD activities to available assistance of the IS faculty or students. [Ref. 15]

There is also no predictable method of disseminating useful IS research findings. The closest function that reveals useful research on a regular basis is the graduate students' theses. The process by which a student chooses his thesis is haphazard at best. In the selection of one's thesis topic, some students are guided by the needs of their former and future duty station sites, while others are "recruited" for ongoing IS projects by faculty members. But for the majority, the search is random for their "useful" topic that "...may or may not help the student." [Ref. 14]

Defense department organizations and military related activities such as air and ship squadrons, shore installations and supply commands to name only a few, are not normally aware nor regularly informed of any assistance, services, or insightful research that the Naval Postgraduate School's IS faculty or graduate students could provide. In fact, much useful information may already be available from previous research; yet only a determined search or a chance encounter would lead one to NPS as a source. The establishment of an IS research center could serve as a "contact point" for many of these activities [Ref. 14]. The interaction between other academic institutions and outside organizations facilitated by existing IS research centers should be no less beneficial to DoD activities in need of assistance.

The mutual benefits typically provided to the academic institutions such as the currency of academic programs and the relevancy of IS issues should also be available to NPS.

For a future research center "to act as a clearinghouse" is an additional function that would be beneficial to the graduate students; and the DoD activities could receive some valuable assistance that is "...well done by students for just [travel] money!" This is comparing the cost of a few thousand dollars to send the student to the activity's site, in relation to the costs that often amount to tens of thousands of dollars, and more, paid by activities to vendors for similar consulting and product service abilities. [Ref. 14]

For the Navy's and the DoD community's many IS needs and the variety of available uses, "...the center could provide a focus." And once these needs and uses are identified, the focus may serve to provide a more efficient use of limited resources, while at the same time helping to loosen funding limits, manpower caps, and billet constraints. [Ref. 13] Although no clear-cut role for an IS research center was specifically stated, the interviewees' statements were forming a pattern for its unifying mission that paralleled that of existing centers; which is, "...to link [the] school's faculty and programs with the IS community they serve." [Ref. 1]

2. Organization

How should the IS research center be organized and what should the staff consist of? It can be assumed that the research staff would consist of the existing IS faculty who choose to participate in the IS research center. A faculty member is allocated a specific number of months each year to perform classroom instruction and, if funded, a separate number of months to conduct research. The faculty can spend their research time in most any manner they choose, including "...within a

research center." [Ref. 16] Except for some who find their time extremely limited due to their participation with professional associations, only one other reason surfaced that might discourage participation within a research center; that being the requirement that all research center members work on one specified project. This factor is supported by a recent survey of NPS IS faculty that found a lack of support for the encouragement of large groups of faculty to work together on one specific project. [Ref. 14]

A director would also likely be a faculty member and could spend his research time as the center's director. It was noted that since a director may need additional time during those months he was expected to teach, the department chairman would consider lightening the director's teaching load commensurate with the director's duties. In turn a director could be beneficial to the department to the point that he could be considered a "vice-administrator" of the department. With the chairman preoccupied primarily with department personnel issues, a director could focus more on director functions that facilitate the purpose of the IS research center. One of those functions, for example, might be to act as principal investigator managing project money. [Ref. 13]

3. Funding: Three Scenarios

Funding is the third issue that was discussed with the interviewees; of specific interest is how might additional resources be found in light of the existing DoD budget environment. Currently NPS funds are limited and an increase in funding is not an event that can be reasonably anticipated; at least not in the near future. The variety of resources that may require funding include a research center's personnel (i.e. director, staff, clerical), its equipment and supplies, the research performed (including travel) and activities related to the dissemination of research

findings. Depending on the extent of a IS research center's operations, the number of personnel may vary. The minimum would include the research participants or staff, a director, and someone to provide clerical assistance.

Although funding to acquire additional equipment, supplies, and clerical personnel may not be so readily available, the existence of an IS research center serves the purpose of focusing attention on that need. One long term benefit noted is that, "...a consortium of professors may be better able to attract funds." Also, as a group the researchers might request fractions of man-years in clerical help that could result in the future hiring of an additional clerical person (e.g., four separate requests for one quarter of a man-year in clerical help, equals one clerical person). [Ref. 16] Additionally, as the center gains recognition and the "needs" and "uses" are more clearly recognized, a further loosening of existing funding limits and constraints in terms of billets (personnel positions), as well as money, might be realized [Ref. 13].

One other possible funding source is the variety of activities an IS research center may choose to conduct such as conferences, seminars, lecture programs and workshops. Although it is recognized that some academic institutions find them extremely profitable, for reasons that are endemic to the Naval Postgraduate School and will be discussed later in this thesis, these activities cannot be considered regular sources of operating revenue over and above the costs of producing each particular activity.

Since neither personnel resources nor additional activities can be expected to cover the initial operating expenses of an IS research center, and the benefits of recognition take time to realize, an interim method of funding a center's costs must be found. To obtain some perspective on possible funding alternatives, three

research scenarios were derived and presented to Professor Shu Liao who has chaired the research task for the Administrative Sciences Department.

The first scenario discussed was the establishment of a research center "in name only", (i.e., primarily for name recognition). Operations within the department would remain essentially the same, and required additional funds (some printing, clerical, and postal costs incurred by an annual report) would be minimal. Because of the minor costs, it is likely they would be approved by the department chairman and, therefore, paid "out of pocket" [Ref. 17].

The second scenario envisions the entire membership of the research center focusing its research efforts on a single large project. In addition to the project's expenses, the additional research center resources needed would likely include a dedicated clerical staff and a research director. To support these resources there are two sources of funding available which are termed either direct or indirect. Direct funds are received from the Navy with prior approval. Approval normally requires the detailed process of indicating a need in very specific terms. However, Professor Shu hinted that in order to successfully encourage a large group of faculty to work together on one large project, "...it would likely be broad or general." [Ref. 17] As mentioned previously, faculty support for a large and narrowly specified group project is lacking [Ref. 14]. Therefore, because of the increased specificity typically required to get project approval, such approval would be even more difficult to obtain.

An additional consideration that renders this scenario unlikely with direct funds is that the total amount allocated to NPS is limited. Because this set amount of direct funds is predetermined and then apportioned among the many departments, the remaining amount available to the Administrative Sciences Department for further

allocation to an IS research center is likely to leave insufficient direct funds for a large project.

The second source, reimbursable funds, would be acquired from a sponsor that is willing to finance the entire project. Because the funds are obtained from a source other than the Navy, the detailed process of approval is no longer a factor. However, convincing a sponsor to commit to a "broad or general" project may become an additional challenge since that type of project is the more likely if most IS faculty are expected to participate. [Ref. 17]

Our final scenario is a center established to support a variety of IS interest areas. It would entail the coordination of a number of projects. Along with a center director, and each project's particular expenses, the additional resources to cover the minimal anticipated costs would include funds for part time clerical help, and the printing and postage incurred for announcement brochures. The existence of a variety of projects prohibits a majority of funding by direct funds simply because expecting the approval of a majority of detailed reports requesting these funds is not a reasonable expectation. Therefore, most of the funding would consist of reimbursable funds. With the center's assistance, funds for each project would be acquired from various project sponsors by individual faculty members. Assuming the faculty members wish to participate, they would then contribute their accumulated funds to the research center. A more detailed and uniform policy for participation, contribution, and allocation would have to be established and agreed upon by the faculty. [Ref. 17]

C. ACTIVITIES

Activities are a reflection of a research center's objectives. As has been previously observed, various IS research center activities can accomplish the dissemination of information and even generate additional funds while, at the same time, serving to increase their interaction with interested organizations and the IS community. As shown in Table 3, some of the more common activities include conducting workshops and symposiums, supporting a working paper series, and linking student projects to outside organizations. [Ref. 2] While proposed activities were mentioned during the interviews, an additional factor considered by the participants was the various difficulties that may be encountered if an IS research center at NPS should conduct these activities.

The activities that are considered commonplace at most existing academic institutions require special consideration at NPS on the part of those responsible for conducting the activity. Most of that consideration centers around the fact that NPS is a graduate education institution funded entirely by the Navy and, therefore, contained and controlled within the Department of Defense budget; a most unique situation within the academic world. Any type of research center would involve the use of school facilities and faculty time. The association of an IS research center with NPS faculty and facilities imparts various regulations which impose restrictions on that research center not normally encountered by other IS research centers.

For example, assuming the research center was to sponsor a conference or seminar, certain restrictions would exist for the use of excess funds. Although direct expenses do not have to consume all revenues (i.e. registration fees do not have to be exhausted by the services rendered), and in fact "...the fees can include some overhead costs....", any remaining revenues cannot be converted to salaries.

In other words, "funds cannot be used for additional clerical or staff personnel." There is a limit as to the number of personnel the school can hire. This limitation includes temporary personnel. [Ref. 13]

Further restrictions may be encountered when considering the types of customers who might attend the various activities, as well as how each is charged for the services. There should be no problems stemming from fees collected from customers associated with Navy or even DoD organizations, as long as the fees cover only incurred costs; however, "...additional charges over and above expenses could be looked upon as a "slush fund"." A similar situation would exist for "non-Navy" customers in that covering expenses would usually present no problems; however, federal laws would govern against charging for a profit when government property and/or personal gain are involved. [Ref. 16] Should the case arise where excess funds do become available, due to reasonable overhead or additional project funds, they would be limited to the purchase of hardware, software, and their related items and equipment. Whether or not the excess funds exist, the source and the purpose for which the funds are eventually used must be strictly accounted for. [Ref. 13]

Because of the natural association of NPS with activities conducted within the school's confines, it is difficult if not impossible to disassociate these activities from NPS. This includes the relatively simple and common activity of disseminating information through a working paper series. The statement by current Administrative Sciences Chairman, Professor Whipple, that "[NPS] operates under different rules and constraints than other institutions....", is indicative of the fact that the establishment of an IS research center at the school would have to work within those unique guidelines [Ref. 13].

VI. NPS IS RESEARCH CENTER: A WORTHWHILE ENDEAVOR

A. THE DOD ENVIRONMENT

There is an increasing number of IS research centers, all of which are involved in the generation of numerous significant studies within the IS field. Yet no research center is specifically focused on the IS issues relating to the Navy or the Department of Defense; and as most publications and periodicals reporting the status of government computing will attest, the issues are significant and cover the entire spectrum of information systems. It is within the DoD environment that an IS research center at the Naval Postgraduate School could make a significant contribution.

With respect to IS issues, the Department of Defense shares many, if not all, of the same concerns as the commercial world. Some of the most common organizational concerns include the following: the impact of information technology; whether to centralize or decentralize; the proliferation of personal computers; the design, application, and control of IS; office automation; life cycle planning and management; how to measure productivity; how to ensure maintainability; system security and data integrity; the development of standards. Because of the unique characteristics of the DoD environment, however, the approach to properly addressing these potentially wide ranging concerns or solving specific problems, may be different than that of the commercial environment.

NPS not only has the ability to customize many of the previously performed studies, but it also has access to the necessary data within DoD. Even if no new or

creative research were done, and only existing studies were reproduced with the "new" data, the resulting information should be of tremendous interest and value to DoD; such as what proposals would or would not apply. This simple task alone has a relatively small cost as compared to initiating a new study from the planning stages through its fruition.

A further benefit is realized by the fact that most studies could be done within the time and resource limitations of a graduate student's thesis. This is not to indicate that an IS research center at NPS would not push the state of the art; but by being aware of its large potential value, for little more than the current investment the establishment of an IS research center at NPS is almost guaranteed to be fruitful. Therefore, it is with a DoD focus that an IS research center should be established. Furthermore, its establishment would yield valuable contributions to the IS field, as well as to DoD.

B. MISSION, ORGANIZATION, AND FUNDING

The overall goal of an IS research center at NPS should be to facilitate the necessary convergence of the existing and available resources of DoD, NPS and information sources in order to properly address significant IS issues within the DoD environment. This goal is similar to that of all other IS research centers in the link it provides between the academic community and the organizations they serve. Borrowing the model provided in Figure 1 of Chapter 1, the original elements can be supplanted by those of the NPS IS research center as shown in Figure 4. More specifically, the mission of the IS research center should be stated to first, identify the relevant IS issues within the DoD environment and investigate the applicability of existing approaches to these issues. Secondly, to instigate and continue to participate in research in an effort to address the unresolved issues. A link does not

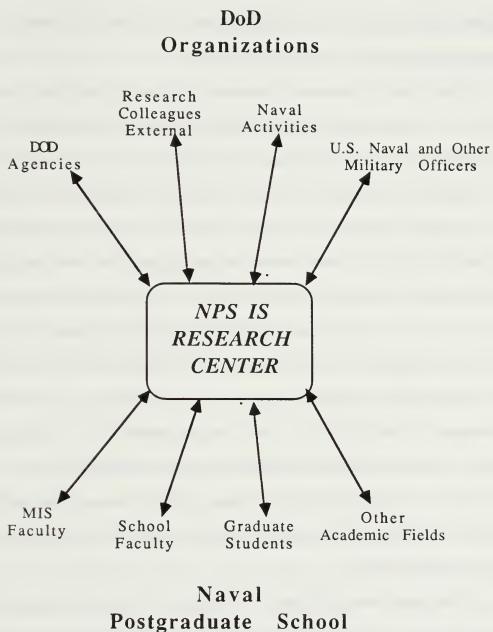


Figure 4 Component Relationships of NPS IS Research Center

efficiently or effectively occur without a vehicle, such as a research center, to facilitate such interaction. The NPS IS research center is that vehicle allowing the maximum return from the available resources.

The mission as stated is purposely "broad based" since, as previously indicated, the issues are not yet specifically identified within the DoD environment. Even if they were so, it can be assumed that initially there would be many. The IS field is dynamic and so are the issues. With this in mind, it is best that the interest areas be defined more in terms of each of the faculty members' preferences within their fields of study. In other words, rather than have the center attempt to identify and then dictate which specific area of interest a member should perform research, the center should initially concentrate on the identification of those issues by attempting to open up communication channels between the DoD community and NPS. It is through a continuous interaction with the "real world" that the issues will begin to present themselves. A more important reason for establishing a broader theme is the current resource limitations of both staff and funding. Without the availability of the alternative of increasing staff or funding in the near future, the probability of being able to properly manage fewer interest areas of increasing complexity diminishes.

There may be an additional advantage to stating a broader mission since a three to five year period is the normal time before an IS research center is considered successful and stable. The shifting of some of the faculty's and school's time and resources, from largely individual commitments to the more coordinated workings of a research center, will itself take some time and effort. [Ref. 2] An additional factor that is involved in establishing the center in its ultimately recognizable form is the estimate that "...a center requires the concentrated effort of a senior faculty

member for more than a year to just establish [itself]." [Ref. 9] A lighter teaching load may be a negotiable "incentive" for the director to assume those tasks [Ref. 2]. For the remaining IS faculty, the center's supportive role toward their particular IS research interest area may be incentive enough to participate. It is also the most the department can initially offer due to the school's limited resources.

Following the establishment of a director, and if previous IS research centers provide any basis for comparison, the remainder of the organization should consist of participating faculty members. By joint planning and pooling of resources it is also possible, if not desirable, to acquire additional clerical staff that would assist in the variety of activities undertaken to carry out the IS research center's objectives. (The particular objectives and activities will be discussed later in this chapter.) Because the primary mission of the school as a whole is "...to conduct and direct the advanced education of commissioned officers", and one of the basics for the recruitment of faculty members is that they have "...a serious interest in teaching....", there is no strictly "research staff", nor should one expect a staff to exist at NPS as resources and restrictions currently dictate [Ref. 18,19]. This follows the trend of previous IS research centers that do not maintain a research staff, and whose faculty generally determine the center's particular areas of interest.

Even though resources are limited (and will continue to be in this time of decreasing DoD budgets), research continues based on the mix of direct funds for Navy sponsored projects, and indirect funds acquired by the faculty members based on their ability to acquire project sponsors. The direct funds are unlikely to increase as they are typically spread among the numerous academic departments at NPS. Indirect funds are the most likely to be affected by the establishment of a research center. Although grants are not out of the question, resent procurement squabbles

between DoD and commercial vendors, as well as conflict of interest charges involving major information technology equipment manufacturers, make their awarding to NPS less likely. And the previous experiences of an IS research center demonstrated that large fluctuations in the level of funding "...affected the center's planning and management." [Ref. 2] Since charging "associates" or affiliated sponsors "dues" is equally out of the question, the NPS IS research center must depend on its supportive abilities and potential clout in assisting the faculty members in their acquisition of research sponsors and accompanying funds.

There is an additional reason to maintain a "laissez faire" approach to the administration of research projects [Ref. 4]. The center depends on the participation of the faculty. The faculty may be encouraged to participate by the clout and credibility that an established research center carries. Equally attractive is the fact that the faculty member can actively pursue an interest area with some personal incentive. In return, the participants should turn over the funds to the research center. The center could perform this repetitive function of allotment and accounting, which would free up additional research time from administrative duties.

With cooperative planning through the center, such pooled resources could eventually result in additional equipment (necessary for the various projects but useful to the center's membership long after the project's completion) and needed administrative and technical help (secretaries and lab technicians). Although no funding can be expected from NPS for the establishment of the research center, indirectly the school will provide computer center support should any work related to the IS research center be conducted through it. Course release time is probable for the research center director and remains at the discretion of the department chairman.

C. OBJECTIVES AND ACTIVITIES

From the mission --more simply stated as the identification of DoD IS issues and the investigation of the applicability of existing approaches through the performance of research-- a series of possible objectives can be identified. Recalling Table 2 as a guide, the recommended objectives pertinent to an IS research center at NPS are as follows:

- Perform research into the development, implementation, and utilization of IS within DoD.
- Promote interaction among IS professionals and academicians.
- Educate, develop, and train IS professionals.
- Provide research environment for students and class projects.
- Disseminate significant research findings to the IS community. [Ref. 2]

The activities that the IS research center at NPS should conduct can be derived from the previously stated objectives. With some variations from Table 3, the following are the recommended activities:

- Conduct workshops, seminars, and symposiums on a periodic basis.
- Entertain sponsored research projects related to the DoD environment.
- Maintain a working paper series.
- Encourage student projects at DoD related organizations.
- Maintain a clearinghouse for the tracking and possible matching of DoD organizations' project requests and graduate student theses. [Ref. 2]

Each of these activities, their benefits, and the objectives they satisfy will be discussed in the following paragraphs.

Although many of the listed activities could assist in the particular objective of "promoting interaction", the most direct means is through programs of well planned

workshops, seminars, and/or symposiums. Such activities lend themselves to scheduling at regular intervals throughout the year and encourage a dependable clientele. They are also a way to convey the fact that NPS is an outstanding source of ideas and qualified help for significantly less than typical contractors' fees. If unable to assist, these programs are extremely beneficial in pointing a concerned party in the right direction for further assistance. Besides a free and valuable exchange of ideas and information, the programs set up an NPS IS research center as a source of information unaffected by "Beltway" or "Pentagon" politics; and begin to establish a singular focus towards the important IS issues affecting DoD.

NPS also benefits by the exchange of information. As the participating faculty members become enlightened, so too are the students. The academic programs are enhanced in their currency and quality. The military officers become increasingly aware of important and real world IS issues that "the Fleet" is currently facing. The programs offer an excellent opportunity for an informative platform, as the officers are also capable of offering unique and valuable insight by applying their "Fleet" experience to the IS issues.

The primary method of "...bringing individual talents and cultures to bear on the problems of IS" is through the activity of sponsored research projects [Ref. 3]. It is an activity that is not necessarily being done effectively or efficiently without the vehicle of an IS research center. It is more of an individualistic and "by chance" approach to "available" issues [Ref. 2]. Although there are numerous IS research centers (a testament to their recognized need by the commercial world), no one is currently coordinating an IS research effort within the DoD environment. Conducting research for pertinent DoD projects is the most valuable means of providing continuous interaction between NPS faculty and the DoD community. It

is an additional method to enhance the academic programs and focus original thought and academic attention on real world issues.

There is also a benefit to be gained by some of the "smaller" DoD organizations and activities. Those with few procurement dollars have an opportunity to solve some of their IS problems by employing the services of the students and faculty of an IS research center. In many cases they will end up with a better quality product for less money [Ref. 14]. "Procurement hassles" that typically prevent some of the easier solutions will be eliminated in those cases where TAD money --a fund used for travel expenses within a particular DoD organization-- can be used. Of equal benefit is the experience gained by the involved students.

"Getting the word to the Fleet" has always been a timely challenge. The continuous support of a working paper series is a consistent way to disseminate valuable and current research findings related to IS issues. As a tool to communicate the research center's direction on a regular basis, it can also enhance the focus of the DoD community's IS needs to a single source. It will likewise increase that community's information resource management (IRM) awareness while informing them of NPS projects and capabilities. A suggestion for the manner in which to commence the working paper series is to encourage each faculty member to produce an "initial" working paper on how NPS and the IS research center could assist the DoD community from the perspective of that particular member's area of interest.

Maintaining the "interactive" links between the DoD community and NPS is as important as their initial establishment. While in many ways this is synonymous with establishing a focus, it must still be worked at to ensure that the needs of the educators, students, academic programs, the DoD community and its IS issues are all properly addressed. Accomplishing this task, and also providing an ideal

research environment for the graduate students, is an objective that can be achieved by encouraging that the students' theses and class projects be conducted on the site of particular DoD organizations whenever possible. There is no better way of gaining experience than while assisting the organization "first hand" in determining their needs. Continued encouragement of an active link will result in greater interaction. [Ref. 2]

D. BENEFITS

There are a variety of benefits to be gained from the various suggested activities, many of which are reinforced by the maintaining of a central clearinghouse for IS research projects. In addition to the objectives of promoting research and facilitating interaction, the following is a list of a few of the benefits:

- Establish a central source of project and thesis topics.
- Provide a better match of interested students to pertinent topics.
- Greater variety of topics available.
- Further establish a central point of contact.
- Prevent unnecessary funds being spent elsewhere.
- Prevent a "random search", and the waste in resources while searching.
- Allow recording and documentation of IS projects, problems, and issues, by various categories (i.e., type, organization, remedy, etc.).

Once a relevant project and/or IS issue has been identified, the center should assist in matching them to interested faculty members and graduate students. It should be understood that it is possible, if not probable, that all identified issues and projects may never be addressed; however, their categorizing, and the initial findings alone, could provide some valuable insight into the present and future needs of DoD related organizations.

E. CONCLUSION

Currently the vast majority of DoD organizations remain at the mercy of technology that is driven by the needs of commercial organizations, and the academic community's response by developing solutions within the commercial environment. Whether or not the solutions are appropriate for the Department of Defense is not certain; but certainly it is not in all cases. The answer will not be fully understood unless it is studied.

Many DoD organizations continue to reach out to commercial vendors for answers to IS related problems and issues. That in itself is not bad. However, as the only alternative, it cannot be an efficient or effective means to arriving at the proper solution. The situation will only worsen because the precedents are few and the "corporate knowledge" is spread ineffectively within DoD to solve, much less identify, the problems and issues for a field as dynamic and diverse as information systems.

In support of its self assigned task to guide the advanced education of its students, the mission of the Naval Postgraduate School states a responsibility "...to foster and encourage a program of research in order to sustain academic excellence." Furthermore, in order to achieve the mission's "...requirements of excellence in quality of academic programs and responsiveness to change and innovation in the technology and management in the Navy" the following educational goals have been established:

- "To enhance continually the contribution of the content of the academic programs to the Navy and the Department of Defense."

- "To sustain intense efforts to provide the best education to the students of the Naval Postgraduate School, and to build a progressively better environment where faculty and students can come together in the search for knowledge and professional excellence."
- "To nurture in students a respect for rigor in thought and discipline in work which will be a hallmark of their pursuit of excellence in their professions."
- "To search for faculty who by their scholarship and fresh viewpoint will bring stimulating presentations to the classroom, new vigor to the laboratory and through their research sustain a program of academic excellence." [Ref. 18]

The objectives of an IS research center that were previously listed are a serious and workable response to these stated requirements and goals derived from the NPS mission.

These graduate students are DoD's future IS managers and professionals; and they arrive at NPS with the most recent experience and first hand knowledge of the existing operational needs within the DoD environment. Research projects and theses will be completed with or without DoD involvement. For the relationship between DoD, its related organizations, and NPS to continue status quo is to waste valuable and ever dwindling resources. Interaction among the various components through a coordinated effort facilitated by an IS research center, would be in the best interests of the Navy and DoD, while ensuring the completed mission of NPS.

APPENDIX A

OUTLINE OF AN NPS BROCHURE

Information Systems

Research Center

*Administrative Sciences Department
Naval Postgraduate School
Monterey, California*

NPS: Excellence Through Education

With ever increasing complexities in technological, managerial, and political/economic fields which affect the Navy, military officers with the intellectual capacity and vision to capitalize on evolving technology and developments are increasingly desirable. This requires officers capable of original thought and the capacity to synergize broad areas of knowledge, analyze complex issues, and appreciate the distinction between what is theoretically possible and actually achievable. Graduate education through rigorous academic programs is the how the Naval Postgraduate School achieves the goal of preparing the commissioned officers for such contributions.

NPS is primarily an academic institution in which the special purposes of the Navy are served through academic programs similar to civilian universities. However, the student body is made up wholly of U.S. and international military officers and federal civilians.

The mission of NPS requires excellence in quality academic programs, and responsiveness to change and innovation in technology and management in the Navy. To this requirement the following educational goals are dictated:

- To contribute to the Navy and the Department of Defense through the enhancement of quality academic programs.
- To provide the best education through a progressively better interactive environment of faculty and students.
- To nurture a respect for rigor in thought and discipline in the pursuit of professional excellence.
- To search for faculty of scholarship and fresh viewpoint resulting in stimulating classroom presentations and vigor in the laboratory as well as sustained academic excellence through research.

It is the responsibility of NPS in the support of advanced education of commissioned officers "...to foster and encourage a program of research in order to sustain academic excellence." It is for the mission and educational goals that the Information Systems Research Center is established.

ISRC: An Introduction

The Information Systems Research Center is a cooperative effort by the Administrative Sciences Department and the Computer Systems Management Curriculum initiated in an attempt to meet the challenges of the dynamic environment of the Information Systems field within the Department of Defense community. It has long been recognized that a very large need for well prepared IS managers with a military service background has existed in "the fleet" for some time, but only recently has a concerted effort begun to respond to that need. The recent inception and continuing support of this IS research center is this department's genuine response.

The establishment of our new Information Systems Research Center promises to provide a number of equally unique challenges to all the participants. What previous research there is in the IS field with respect to research centers indicates that the entity that is ultimately established only reveals itself after 2 or 3 years of active participation. Initially participants will consist of members for the Information Systems group of the Administrative Sciences Department.

For the "run-up" period of the center and as we test the waters, the primary goal of the IS research center will be to establish effective channels of communication with the various activities in the field who can benefit from our research findings. Through our efforts we hope to adequately identify the significant IS issues within the Department of Defense. Once identified, the applicability of existing approaches to these issues will be investigated. Of even greater importance is the experiences from which we expect to learn, advancing the education and participation of the Naval Postgraduate School's primary concern... the graduate students. It is only through their determined participation that the NPS IS Research Center will be successful achieving the present goals and future objectives.

ISRC Activities (proposed)

Working Paper Series

Our efforts to "kick off" our working paper series concentrates on informing interested professionals of our research capabilities and efforts with respect to the DoD community. Each of our ISRC members has provided an "initial" working paper from the perspective of that particular member's area of interest, primarily to denote the available methods of addressing perceived DoD IS issues.

Symposium

Currently, symposiums are seen as the best method of determining the most pressing IS issues and needs of the DoD community. It is also ISRC's most effective procedure for disseminating pertinent ideas and recent research findings to interested IS professionals, DoD component activities and related organizations. With DoD's fiscal year beginning 1 October, and since planning is a significant factor in the "success" of both information systems and the timely acquisition of them, a Fall symposium is pictured as an excellent means to commence the process. Active participation as well as attendance is encouraged for the benefit of all.

Clearinghouse

A variety of potential projects and their related IS issues are known to various personnel in a variety of places throughout the DoD community. In an effort to identify the projects, issues, and their related organizations, a central clearinghouse has been established to provide one type of focal point for information systems within DoD. It will attempt to track and document prospective subjects for research, while possibly matching them to interested faculty members and graduate students.

Additional Activities

The anticipated activities are not limited to those listed above; however, the NPS ISRC is only in its dawning stages. The remaining effective possibilities such as workshops, lecture programs, seminars and other activities that encouraging the participation of the DoD community, will require some analyzing in addition to time, effort and funding.

IS Faculty

Tarek K. Abdel-Hamid, Assistant Professor of Management Information Systems, Naval Postgraduate School, is in charge of the colloquium program for the Information System Group. The focus of his research is the management of large software development projects using Forrester's system dynamics engineering. He is interested in the coupling of artificial intelligence with simulation in the development of expert simulators. Prof. Abdel-Hamid advises NASA's Jet Propulsion Laboratory on the development of decision support system tools for managing software development projects. He has been associated with the Stanford Research Institute and the Center for Information Systems Research at MIT. He earned his Ph.D. in management information systems at the Sloan School of Management at MIT. Prof. Abdel-Hamid is the co-author of the *Dynamics of Software Development* (prentice-Hall, 1989). His articles on software development have appeared in *Annals of the Society of Logistics Engineers*, *IEEE Software*, *IEEE Transactions on Software Engineering*, *Information & Management*, *Journal of Systems & Software*, *Journal of Management Information Systems*, *Management Information Systems Quarterly*, and *Systems Dynamics Review*.

Tung X. Bui, Associate Professor of Management Information Systems Naval Postgraduate School, has taught and published extensively in the field of group decision support systems and the economic evaluation of information systems. His current interest is in distributed expert systems. He also studies the economic evaluation of expert systems. Prof. Bui completed his Ph.D. in managerial economics at the University of Fribourg and a Ph.D. in information systems at New York University. He is the author of *Co-op: A Group Decision Support System for Cooperative Multiple Criteria Decision Making* (Springer-Verlag, 1987). His articles on decision support systems have appeared in *ACM Transactions on Office Information Systems*, *Computers & Society*; *Journal of Parametrics and Systems*, *Objectives and Solutions*.

Daniel R. Dolk, Associate Professor of Management Information Systems, Naval Postgraduate School, is the academic associate for the information systems curriculum and Associate Chair for Instruction in the Department of Administrative Science. His current research interest is model management in decision support systems. He is interested in the application of hypertext and optical disk technology to information resource management. Prof. Dolk has helped develop a decision support system as part of the *Fly-Away Management Information Systems (FAMIS)* for maintaining communications in a national emergency and is involved with database design for the Navy's RAMP flexible manufacturing system. He has worked with the Naval Security Group, Defense Communications Agency and the Naval Supply Command. Prof. Dolk received his Ph.D. in management information systems from the University of Arizona. His published works on model management have appeared in *ACM*, *Decision Support Systems*, *IEEE Transactions on Software Engineering and Information & Management*. Prof. Dolk is an Associate Editor of the *ORSA Journal on Computing*.

Barry A. Frew, Adjunct Professor of Information Systems, Naval Postgraduate School, is in charge of the thesis program for information systems students. He is studying the application of optical storage technology. His work includes the digitizing of large databases that are maintained manually as well as the storage and access issues. He is interested in the use of optical storage for data management and decision support systems. His attention is further taken by the prospects for automating systems analysis, design and development, particularly by the use of computer-assisted software engineering(CASE) tools. Prof. Frew has been working on aspects of the Paperless Ship project, including the exploration of the idea of a paperless library. He has worked also with the Navy Supply Headquarters and Naval Data Automation Command Headquarters to shift paper documentation to optical storage. As a Navy supply officer, Prof. Frew was inventory manager for the Naval Supply Center at Pearl Harbor and assistant director of the environment department of the Navy Maintenance and Supply Systems Office in Norfolk where he was in charge of systems design, database management, data dictionary/directory system management, standards and software engineering policies. He received his masters degree in management information systems from the Naval Postgraduate School.

William J. Haga, Adjunct Professor of Management Information Systems, Naval Postgraduate School, is studying the research methods used to gauge the success of information systems. He is assessing system effectiveness by the collecting of field data on inputs and outputs in a quasi-experimental design. He is interested in the by-products of systems implementations on small groups using attitudinal surveys supported by unobtrusive measures. His other research interests include the relationship of organizational structure and culture to information system effectiveness. Prof. Haga has recently studied the need for security violation databases throughout DOD. Previously, he has examined the utility of the Naval Occupational Data Analysis Center for the structuring of training for enlisted ratings by CNET. As an emigre to management information systems from social psychology, he is known for his work on the process by which organizations assimilate new members into their roles. He completed his Ph.D. in organizational theory at the University of Illinois. His published works have appeared in Academy of Management Review, Accounting Review, American Journal of Economics and Sociology, American Sociological Review, Astronautics and Aeronautics, Behavior Science, Journal of Contemporary Sociology, Journal of the System Safety Society, and Organizational Behavior and Human Performance. He contributed a chapter on the social origins of American engineers to Technology, the University and the Community (Pergamon Press, 1976).

Carl R. Jones, Professor of Information and Telecommunication Systems, Naval Postgraduate School, chairs the Joint Command, Control and Communications academic group. His foremost research interest is the relationship of the structure and processes of organizational systems to the success of their information systems. He is also pursuing the effect of cognitive constructs upon the quality of command decision making, with a particular interest in the use of software to simulate decision making in combat. He has a further concern with the education and experience needed to develop knowledge engineers. Prof. Jones has worked for the Autonetics Division of Rockwell International and the ASW division of Aerojet General. He completed his Ph.D. in economics at the Claremont Graduate School. He is co-author of Information Systems Management (Elsevier, 1985).

Magdi Kamel, Assistant Professor of Management Information Systems, Naval Postgraduate School, is interested in database management systems including data modeling and database languages. He is also studying the use of databases in expert systems and decision support systems. He has a further concern with the performance of centralized and distributed databases, particularly the time-critical performance of databases used in military decision support systems. He is a member of the multi-model database system project at the Naval Postgraduate School. As a consultant-analyst for NCR Corporation, Prof. Kamel implemented software applications in accounting, manufacturing and inventory management. Prof. Kamel earned his Ph.D. in management information systems from the Wharton School. His work on database techniques have appeared in a series of technical reports published by the University of Pennsylvania.

Robert L. Knight, Lieutenant Commander, United States Navy, Instructor, Naval Postgraduate School, is studying the success of information resource management in military systems. He is interested in the development and effectiveness of the concept of the Chief Information Officer in large organizations. He has worked with the Naval Data Automation Command to improve the means for field activities to develop realistic and attainable plans for management information systems. He was program manager for the Type Commander Headquarters Automated Information System (THAIS). LCDR Knight completed his masters degree in management systems at the Naval Postgraduate School.

Martin J. McCaffrey, Adjunct Professor of Management Information Systems, and Acquisition and Contract Management, Naval Postgraduate School, specializes in the development of information systems for integrated logistic support of military operations. He is interested in the planning and development of tactical software and expert system applications. He is an authority in managing the acquisition of information systems. Prof. McCaffrey was program manager for a DARPA research project that led to the use of gallium arsenide in hybrid processor chips. He also managed the acquisition of the Position Location Reporting System, and the Global Positioning System for the U.S. Marine Corps. He pioneered the use of laptop computers with E-mail to link remote program management teams. Prof. McCaffrey earned his masters in management information systems from the Naval Postgraduate School.

Leon R. Sahlman, Instructor, Management Information Systems, Naval Postgraduate School, manages the use of the computer laboratories in the Department of Administrative Sciences for support of instruction in programming and information systems management. Before joining the information systems group at NPS, he taught programming at New Mexico State. Mr. Sahlman completed his masters degree in management information systems at Golden Gate University.

Myung W. Suh, Adjunct Professor of Management Information Systems, Naval Postgraduate School, specializes in the study of the allocation of both data and data processing resources in distributed computer systems. He is concerned with networking technologies and with the organizational and economic motives for distributing information resources. He has a further interest in the ways in which information technologies affect the accounting and internal control procedures. Prof. Suh has worked at GTE Labs and has been a staff auditor with Coopers and Lybrand. He is working on his Ph.D. in computers and information systems in the Simon School of Business at the University of Rochester.

Norman F. Schneidewind, Professor of Information Systems, Naval Postgraduate School, is Technical Director of Computing, responsible for computer laboratories for the Department of Administrative Sciences. He has taught and published extensively in the field of software reliability. He is the author of the Schneidewind Software Reliability Model. IBM's Integrated Systems Division selected the Schneidewind Model for having the best fit to data in post-Challenger software reliability analysis for NASA. The Schneidewind Model is also used by Naval Surface Weapons Center and Hughes Aircraft. Prof. Schneidewind's current research deals with the architecture of networks. He is also drawn to the development of software quality metrics. He has chaired the IEEE Software Quality Metrics Standards Working Group. Prof. Schneidewind has worked on software reliability models for the Fleet Combat Direction Systems Support Activity and the Naval Electronics Laboratory. He is developing a metrics and software reliability model for the Naval Management Systems Support Office. He has received the Commissioner's Award for the development of a distributed information system for the U.S. Customs Bureau. Prof. Schneidewind earned his DBA in Quantitative methods from the University of Southern California. His published works in software engineering have appeared in the Communications of the ACM, IEEE Computer, IEEE Transactions on Reliability and IEEE Transactions on Software Engineering. He has contributed articles on networks and teleprocessing to IEEE Transactions on Software Engineering, IEEE Computer and the Encyclopedia of Science and Technology (McGraw-Hill, 1986). Prof. Schneidewind is an editor of IEEE Transactions on Software Engineering.

Moshe Zviran, Assistant Professor of Management Information Systems, Naval Postgraduate School, focuses his research on strategic planning of information systems. He also studies information systems in the Health care facilities. He is interested in the development of decision support systems, economics of information systems and computer security management. Prof. Zviran served as a consultant in these areas for several organizations. He has held professional positions in information systems in private and public organizations. He earned his Ph.D. in computers and information systems from Tel Aviv University. His published works have appeared in Information and Management.

APPENDIX B

BROCHURES OF EXISTING IS RESEARCH CENTERS

CENTER FOR INFORMATION SYSTEMS RESEARCH

ANNUAL REPORT 1987 - 1988

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MESSAGE FROM THE DIRECTOR

"There has never been a more exciting time in the information systems field. Computers and communication systems are providing what appear to be almost unlimited capabilities. And the need for these capabilities by business and nonprofit organizations alike is increasingly clear. For those in the field, the opportunity to make extremely significant contributions to the success of their organizations is at an all time high."



These words could have been written, and similar ones have been, at any time during the past thirty years. The technology has improved year by year. Opportunities to utilize computers and telecommunications have grown apace. And, increasingly, business executives are understanding and taking advantage of these opportunities. Why then start this column with the same, almost trite phrases?

It seems to me that these words demand re-examination and re-emphasis today. As we move toward the 1990s, two driving factors are giving them new and more important meaning than they have had in the past. One factor is the ever more competitive nature of the business world. The second is the increasing recognition of the interdependence of the various parts of industrial organizations coupled with the major role that information technology can play in helping business leadership manage that interdependence.

The first of these factors, increasing competitiveness in the global economy, needs little explanation. It is well known what competition from Japan (and now Korea) has done to the U.S. automobile business and other heavy manufacturing industries. This challenge, however, is extending to many other sectors. For example, Japan's Kao Corporation, a major player in its home market, has established a base in Cincinnati, through its purchase of Jergens. Kao has thus moved into Procter & Gamble's hometown and is evidently preparing its move into the U.S. marketplace for soaps, lotions and shampoos. The financial

industry is another probable target. U.S. and European organizations in the banking and insurance fields are gearing up as the Japs threaten to bring their much lauded manufacturing expertise to the "manufacturing" of financial transaction processing. The need "to do things better" in these and all other industries is starkly evident today.

The second current driving factor is the emerging understanding in management circles that organizations cannot be separated into little pieces and managed as such. Rather, as Prof. Jay Forrester of the Sloan School has stressed for years, organizations are dynamic systems. Each part, in one way or another, dependent on the functioning of other parts. In short, multiple interdependencies exist within every organization and each of these interdependencies must be managed. Here are a few examples of the more obvious organizational interdependencies:

- In the product development process, the design, manufacturing engineering, and manufacturing organizations must work together to get products to market quickly. Today, this is well understood and facilitated in most organizations through CAD/CAM based design processes that support product development teams drawn from the various functions.
- For product maintenance, most machine manufacturers have developed product training systems which allow a corporate view of maintenance issues occurring throughout the entire customer base. No longer is a district office viewed as a maintenance island off itself. Rather, it is recognized that maintenance issues affecting machines of a particular type in one region may shed light on maintenance problems and opportunities "worldwide".
- At the very simplest level, what the manufacturing department does heavily affects the purchasing department - and vice versa.
- A bit less simply, the ways in which data is defined and coded by suborganizations hugely affect management's ability to manage, on a company-wide basis, customers, vendors, inventories and many other corporate "assets".
- Today, the rush of organizations to become "global" enterprises is, in large part, a recognition of the interdependencies from country to country, and a desire to organize and manage accordingly. The issues facing multinational firms include the need to present a "one-company" image to customers; have uniform standards for product and manage risk globally.

One could go on with examples such as these. The key point is that, although communication and the need to manage interdependencies are certainly not new, they are today in the forefront of the thinking of many senior executives. Information technology clearly does provide the only answer to these pressing problems. But it does offer some striking opportunities. And both the problems and the opportunities are at the very heart of the business. It is what leads to the renewed and heightened excitement in the field of information technology noted in the opening paragraphs above.

The use of information technology to gain secure "competitive advantage" has been extremely well, perhaps too well, documented. The ability to manage interdependence through information technology is far less well explored.

Managing Interdependence

It is for this reason that a number of CISR researchers currently are addressing the area of managing interdependence. The projects underway have different basic objectives, different methods, and distinctly different outputs. There is significant convergence of theme. A few prime examples of this are:

Tom Malone is working toward an overview of what he terms "coordination science" — the theory underlying the various types of coordination mechanisms which are put in place to manage interdependencies in any organization. He is engaged in several different specific research projects as a means of getting a more general view of coordination theory. One of these projects, noted later in his report, is the development of the Information Lens system which allows selective dissemination and receipt of information in an organization. He has also proposed joint field work with Professors John Carroll and Deborah Ancona of the Behavioral and Policy Sciences group at Sloan to study existing coordination processes in a selected set of organizations.

Stuart Madnick has been working toward increased understanding of the technical systems integration which must be put in place to support coordination and interdependence. The overall goal of his research is to facilitate integration of information from disparate systems to support strategic applications. This involves focusing on both physical and logical data connectivity. Stu is also emphasizing the organizational issues that may present obstacles to cooperation.

- John Henderson has been studying the interaction of members of systems design teams, and the functionality provided to them by computer-based tools (e.g., CASE tools). He has evidence to show that (1) the quality of the output of the team is related to the level of cooperation and interdependence that exists among the experts representing the variety of functional areas that make up the team; and (2) the CASE tools can have an impact on the interaction within the team.

- Christine Bullen, Jim Short and I have been studying several key examples of utilizing information technology to both manage and exploit the interdependencies which exist in organizations. Included among the types of technology are CAD/CAM, common systems, and computer conferencing. These systems are being used to support the managerial needs of integration across the value chain and integration among functional units. They also support global management, and traditional vertical and horizontal coordination processes as well as more ad hoc team and informal group processes.

- Jim Short has recently completed a study of a major corporation's reorganization of its I/S function. This I/S realignment accompanied the firm's shift from a functional to a product line organization, and its growing emphasis on providing an integrated, one-company interface to its customers. As a

result of the company's planning efforts, I/S is now positioned to support the growing interdependence among the product line organizations in achieving the one-company program.

The utilization of information technology to manage the increasingly recognized interdependence of functions, product lines, geographical areas and other aspects of organizations is thus a major focus of CISR research. We believe this field of study has much to offer both our sponsors and other organizations.



John F. Rockart
July 1988



OVERVIEW

The Center for Information Systems Research (CISR) was established at MIT's Sloan School of Management in 1974 to define, research, and report on significant managerial issues in the utilization of computer-based information systems. The relevance of this research is ensured through interaction with senior managers in business and government.

Research at CISR is pragmatic, problem-based and application-driven. A select group of sponsoring organizations, representing a broad range of industries, assists in defining and investigating research on fundamental issues affecting the public and private sectors in such areas as: managerial use of computers; information technology; the management of the information systems function; and the impacts of information systems on organizations. CISR disseminates its research findings through teaching programs, seminars, working papers, and publications.

CISR's core staff includes the members of the Sloan School's MIS faculty plus several full-time research associates. These individuals represent a wide range of academic disciplines and specialized training, ranging from the technical fields of computer science and electrical engineering to the people-oriented fields of law, psychology, and organizational behavior.

Their academic strengths are balanced by a strong recognition of business needs, a balance essential for keeping the research focused on issues of effectiveness. CISR is also able to involve experts from other areas at MIT, and from industry, in particular projects when appropriate.

A team approach to research allows a multi-disciplinary investigation of relevant concerns. Although to some extent everyone participates in each stage, the faculty leads the research design, the research staff manages the projects, and students contribute significantly to data gathering and analysis.

The involvement of graduate students in the research process results in several mutually beneficial relationships. The Center has a source of capable and enthusiastic human resources to carry out research. Sloan School students have meaningful and challenging professional experiences as they accomplish their course projects and theses in a variety of business environments. Sponsoring organizations benefit from the extensive research and increased knowledge of important issues concerning information systems. Thus, the MIT Sloan School of Management benefits from the educational experiences realized by both its faculty and students.

In summary, the mission of CISR is to bring a broad range of disciplines and input from industry to bear on critical questions concerning how managers can take advantage of continuing advances in the information systems field.

FACULTY AND RESEARCH STAFF



Christine V. Bullen, Research Associate and Assistant Director, CISR, is currently involved in a major study of the impact of information technology on organizational structure, processes and managerial behavior. She is also studying "groupware", computer-based tools which facilitate the work of teams, by reviewing the products in the field today and by examining the nature of group work. She has conducted research concerning the impacts of office systems; career path issues for I/S professionals; the use of the critical success factors methodology; and the design and implementation of distributed processing. Her industry

experience includes the corporate planning staff of Inforex, Inc.; and the professional staff of Arthur D. Little, Inc. Ms. Bullen received her master's degree from the MIT Sloan School. She is co-editor of *The Rise of Managerial Computing: The Best of the Center for Information Systems Research* with John F. Rockart.



Randall Davis, Associate Professor of Management Science, MIT Sloan School of Management, specializes in the expert systems and artificial intelligence and is Associate Director of the MIT Artificial Intelligence Lab. He received his Ph.D. from Stanford University in 1976 and spent two additional years there as a Chaim Weizmann Postdoctoral Scholar. At Stanford, he was an early contributor to the Mycin Project and developed a system for knowledge acquisition in expert systems. Dr. Davis was on the faculty of MIT's Department of Electrical Engineering and Computer Science from 1978 to 1984. He serves on the editorial boards of *Artificial Intelligence*, *Generation Computing*, and *Knowledge Engineering Review*, and is the co-author of *Knowledge Based Systems in AI* with D. L. His current research focuses on building the next generation of expert systems, exploring programs that use model-based reasoning.



John J. Donovan, Associate Professor of Management Science, MIT Sloan School of Management, specializes in new technological related to decision support systems and public sector policy analysis. Prior to his appointment at Sloan, he served as an associate professor of electrical engineering at MIT. Prof. Donovan was the director and a founder of the Center

Birth Defects Information Systems at New England Medical Center. His industrial experience includes founder of Knoware, Inc.; founder and former chairman of the board, AROL, Inc.; founder and former president of INTERCOMP; and board member, Financial Publishing, Inc. He is the author of *Systems Programming* and co-author of *Operating Systems* with Stuart E. Madnick. Prof. Donovan is currently on academic leave.



John C. Henderson, Associate Professor of Management Science, MIT Sloan School of Management, has taught and published extensively in the fields of decision support systems, MIS design and implementation, and the strategic impacts of information technology. Other current research topics include the value of strategic information systems planning and the impact of computer-based design tools on the performance of design teams. Prior to his Sloan School appointment, Prof. Henderson was on the faculty at the Wharton School (University of Pennsylvania), Ohio State University, and Florida State University. Prof. Henderson received his Ph.D. from the Univer-

sity of Texas, Austin and has served in the public sector as staff director for the Joint Select Committee on Electronic Data Processing, Florida State Legislature.



Chris F. Kemerer, Assistant Professor of Management Science, MIT Sloan School of Management, focuses his research on the management and measurement of information systems with a current emphasis on software engineering topics. Prof. Kemerer received his Ph.D. in systems sciences from Carnegie-Mellon University in 1987. His dissertation developed an empirical model of the factors affecting software maintenance productivity. In the four years prior to his graduate studies, he was an information systems consultant and managed large systems development projects.



Stuart E. Madnick, Professor of Management Science, MIT Sloan School of Management, and affiliate member of the MIT Laboratory for Computer Science, is in charge of the Sloan School's information technology courses. His current research interests include composite information systems, database technology, and software project management. He has been active in industry, especially in the design and implementation of advanced information systems in medicine, manufacturing and information retrieval. Prof. Madnick is associate editor of *ACM Transactions on Database Systems*. He has written books and articles on computer science, management information systems, and data security, and edited *Planning for the Strategic Use of Information Technology*, a collection of *Sloan Management Review* articles (Oxford University Press, 1987).





Thomas W. Malone, the Douglas Drane Career Development Associate Professor of Information Technology and Management, MIT Sloan School of Management, focuses his research on how artificial intelligence and other computer technology can help people work together in groups and organizations; and how organizations can be designed to take advantage of the new capabilities provided by information technology. Before joining the MIT faculty, he was a research scientist at the Xerox Palo Alto Research Center (PARC) where his research involved designing educational software and office information systems. Prof. Malone's background includes a Ph.D. from Stanford University and degrees in applied mathematics, engineering, and psychology. He is on the editorial boards of *MIS Quarterly* and *Organizational Science*.



Jeffrey A. Meldman, Senior Lecturer, MIT Sloan School of Management, specializes in legal and social problems arising from the use of computer-based information systems. He is Director of the Sloan School's undergraduate programs and Associate Dean for Student Affairs at MIT. He received the J.D. degree from Harvard Law School and the Ph.D. degree in

computer science from MIT. Dean Meldman's teaching and research have focused on privacy and security, protection of proprietary rights in software, and formal models for legal analysis. He has served as chairman of the Massachusetts Security and Privacy Council and as a privacy consultant to the U.S. Federal Judicial Center, Congress's Office of Technology Assessment, and the City of Cambridge Commission on Cable Television.



Wanda J. Orlowski, Assistant Professor of Management Science, MIT Sloan School of Management, will join the faculty at the end of 1988 after completing her doctoral work at New York University. Her research concerns the nature, control, and performance of computer-mediated work, and its implications for individuals, work groups, and organizations. In particular, her dissertation focused on computer-aided software engineering, and the relationship of this technology to the skills, processes, and practices of systems development. She received two bachelor's degrees and a master's degree from the University of Witwatersrand in Johannesburg, and was a lecturer in information systems there for four years.



Judith A. Quillard, Research Associate and Associate Director, CISR, is currently conducting research on the management of data as a corporate resource. She has been involved in study of the management of end user coming and a major survey of I/S and user managers which addressed such issues as top priorities for I/S management and user demand for new systems. Ms. Quillard received her master's degree from the Sloan School, holds a bachelor's degree in mathematics from Tufts University. Prior to joining CISR, she worked as a software engineer at a high technology firm and as a technical project manager for a systems consulting organization.



John F. Rockart, Director, CISR, and Senior Lecturer of Management Science, MIT Sloan School of Management, has taught and conducted research within the areas of management planning and control, and the use of computer-based information systems. His most recent research interests are the "critical success factors" concept, the use of information



management, the management of the data source, and the partnership between I/S and management. Dr. Rockart is also supervising a major project on the impact of information technology on organizational structure and processes. He serves on the boards of directors for three organizations and consults and lectures for several major companies. Prior to joining the Sloan School in 1966, Dr. Rockart spent four years with IBM. He is co-author of *Decision Support Systems: The Emergence of Management Computer Use* with David W. De Long, and co-editor of *The Rise of Managerial Computing: The Best of the Center for Information Systems Research* with Christine V. Bullen.



Michael E. Treacy, Professor of Management, MIT Sloan School of Management, is currently director of the school-wide "Management in the 1990s" research program. He has extensive research and consulting experience in design and implementation of decision support systems, and also in the application of DSS to strategic planning. His current research



addresses the impact of information technology on corporate strategy. Before coming to MIT, he was an IBM Fellow at Harvard University where he received his doctorate. He is author of *Management Decision Systems* and co-author of *Decision Support Systems: An Organizational Perspective* with Peter G. W. Keen; *Management Decision Support Systems* with Andrew McCosh; *Computers and the Learning Process* with John F. Rockart; and *Strategic Control* with Peter Lorange and Sumantra Ghoshal.



James E. Short, Research Associate, CISR, is studying the impact of information technology on organizational structure, process and managerial behavior. He is interested in how technology has enabled organizations to execute differential strategies through enhanced integration and flexible, problem focused teams and task forces. Dr. Short has also conducted research on the strategic use of information technology, on the integration of I/S and strategic business planning, and on the systems design process. Before joining CISR, Dr. Short worked as a management consultant with the Index Group, as a research associate at Arthur D. Little, Inc., and as a manager and end-user consultant at the Office for Information Technology, Harvard University. He received his S.B., S.M. and Ph.D. degrees from MIT.



Hoo-min D. Toong, Research Associate, MIT Sloan School of Management, is principal investigator of research projects dealing with processor architectures, their relationship to the software/hardware issues of distributed multiprocessor systems, and their impact on organizations. He has served on the MIT faculty at the Sloan School and the Department of Electrical Engineering and Computer Science, and has received several teaching awards. Dr. Toong has been active in both government and private industry, developing technology education programs, and participating in the design and implementation of advanced hardware and software systems. He is in charge of the CISR Digital Systems and Personal Computer Laboratory. Dr. Toong is co-editor (with Dr. Amar Gupta) of *Advanced Microprocessors and Insights into Personal Computers*.



Michael E. Treacy, Assistant Professor of Management Science, MIT Sloan School of Management, is studying the impacts of information systems on the performance of the individual, the work group, and the corporation. He is interested in measuring and evaluating impacts at these various levels. Other areas he has researched include decision support systems, the strategic use of information technology, and the design of support systems for senior executives. Prof. Treacy received his doctorate in MIS from the Sloan School. He frequently lectures for industrial audiences on the topics of the strategic role of information networks and the impact of information technology on marketing and sales functions. He will be on academic leave during 1988-89.



ASSOCIATED RESEARCHERS

One strength of CISR is its association with faculty and research staff from other areas of the Sloan School and MIT, and researchers and managers from other organizations.

Robert L. Benjamin, Manager of Corporate Strategies and Programs for Information Management at Xerox Corporation, has a part-time appointment as a CISR Fellow and Visiting Scientist at the MIT Sloan School. He is involved in both CISR and the Sloan School's "Management in the 1990s" research program. His research interests concern the management of the I/S function and the impact of information technology on corporate strategy. He is the author of *Control of Information System Development* and his articles have appeared in *Communications of the ACM*, *MIS Quarterly*, and *Sloan Management Review*.

Dr. Amar Gupta, Principal Research Associate, MIT Sloan School of Management, researches the areas of advanced multiple microprocessor systems architecture, personal computers, and the transfer of information technology to developing nations. He holds a master's degree from the Sloan School, and a doctorate in computer technology from the Indian Institute of Technology, Delhi. His third book, *Insights into Personal Computers* (with Dr. Toong), contains contributions from a number of academic and industry leaders in the personal computer field.

Robert Johansen, Senior Research Fellow, Institute for the Future (IFTF), Menlo Park, California, has worked extensively in the fields of telecommunications and computing. He has focused on the psychological, social, and organizational effects of new systems. Most of his work involves needs assessment, new business opportunities, pilot testing, evaluation, and market forecasting. He is a CISR Fellow and Research Affiliate at the MIT Sloan School of Management, and is collaborating with

Christine Bullen on research in computer-supported cooperative work. A sociologist with an interdisciplinary background in social sciences, he holds a doctorate from Northwestern University. Dr. Johansen is the author of *Teleconferencing and Beyond: Communication in the Office of the Future*.

N. Venkatraman, Assistant Professor of Management, MIT Sloan School of Management, conducts research and teaches in the area of the formulation and implementation of business strategies, with particular emphasis on the emerging impact of information technology on the scope of business strategies. He has published extensively in several scholarly and managerial journals such as *Management Science*, *Strategic Management Journal* and the *Sloan Management Review*, and has served as a consultant to corporations in the area of strategy formulation and implementation. Prof. Venkatraman holds a Ph.D. degree in business administration from the University of Pittsburgh, an MBA degree from the Indian Institute of Management, and an undergraduate degree in mechanical engineering from the Indian Institute of Technology.

DOCTORAL CANDIDATES

The MIS doctoral candidates at the Sloan School usually become significantly involved in CISR's research, often working as research assistants on various projects. The topics they investigate for their dissertations add to the range of CISR's research portfolio.

Two MIS Ph.D. students graduated last year. **J. Yannis Bakos** is now an assistant professor at the University of California, Irvine. His dissertation was a theoretical analysis of the of interorganizational systems to create competitive advantage. **Dale L. Goodhue**, now an assistant professor at the University of Minnesota, is continuing his research on data management issues.

Soonchul Lee, who will join Boston University's faculty when he completes his dissertation later in 1988, received his bachelor's degree in industrial engineering from Seoul National University and his master's degree from the Korea Advanced Institute of Science and Technology. He is researching the various impacts of computer-aided software engineering tools on the performance of design teams. **Kevin Crouston** is currently studying the engineering change process in large manufacturing organizations to better understand the ways in which groups coordinate their activities and to show how information systems can affect the costs of coordination. A member of the Information Lens development team, he is also interested in new technologies, especially in the field of groupware. He holds a bachelor's degree in applied mathematics and computer science.

As part of his dissertation research, **Michael Epstein** is developing and testing a model focused on planning and control of the application development process. Prior to attending Sloan, he worked for five years as a



ions researcher and systems analyst. He
ed a B.A. in economics from the Universi-
Saskatchewan. *David C. Robertson* has
his research on three different areas:
seemingly similar groups use computers in
different ways; how computers affect the
ture and processes of the organizations
them; and how CAD systems help coordi-
efforts on large design projects. He has a
lor's degree in engineering from the
iversity of Illinois and a master's in man-
ement from Sloan. *Andrew W. Trice* holds
in computer science from the University
Maryland. His current research focuses on
elating the construction of knowledge bases
in reflect a consensus of multiple experts.

Mustapha Bensaou holds an M.S. in
engineering from Ecole Nationale des
s, Lyon, France, and an M.A. in manage-
t science from Hitotsubashi University,
yo, Japan. He is interested in studying how
frican and Japanese firms use information
nology, focusing on underlying differences
ecision-making, organizational structure,
managerial practices. *Jay Cooperider* is
osing his research on I/S planning and
egn. He has an S.B. from MIT in electrical
neering and computer science and has
ked as a systems engineer for IBM.
Kambil's research interests include
rganizational systems and the impacts
nformation technology on the structure
rganizations and industries. He received
S.B. in electrical engineering from MIT
1985.

Two students entered the doctoral
gram in September 1987. *Mark Ackerman*
ds a B.A. in history from the University of
icago and an M.S. in computer science from
io State University. He has eight years of
xperience in software engineering
nd product management. *Stann Obonofsky*
is an information systems consultant at
hur Andersen & Company for ten years, most
rently as a senior manager in the firm's
ecutive support systems practice. He has a
achelor's degree in mechanical engineering
nd a master's in operations research.

ADMINISTRATIVE STAFF

CISR's administrative and support staff coordi-
nates the operations of the central CISR office,
manages our various seminars, and is responsi-
ble for CISR publications. *Eleanor Egan*, a
member of the Administrative Research Staff, is
the business manager responsible for financial
accounting and coordination of seminars. She
has extensive experience in office management
and administration at MIT. *Deborah Small*,
Administrative Secretary, supports CISR's direc-
tor and associate director. A graduate of the
University of Maine, she managed the phone
order operations of a small business prior to
joining CISR. *Mary Bucci*, Senior Office Assis-
tant, handles the distribution of the CISR Work-
ing Paper Series. She received her bachelor's
degrees in English and fine arts from Tufts
University and has studied sculpture in
Switzerland.



DESCRIPTION OF RESEARCH AREAS

Given CISR's objective of performing manage-
rially relevant research in the information
systems field, the areas selected for research
span a wide spectrum of issues from "techni-
cal" problems to "organizational" concerns.
From a general perspective, CISR's research
portfolio can be divided into four major cate-
gories: (1) the managerial use of computers and
computer-based information; (2) understand-
ing key information technologies; (3) the
management of the information systems func-
tion; and (4) the impact of information tech-
nology on organizations.

Management Use of Computers and Computer-Based Information

A theme underlying much of CISR's
research has been the importance of the use of
computer-based systems by managers. Since
the late 1960s, Sloan School faculty have done
extensive work in the area of decision support
systems (DSS). The critical success factors
(CSF) method was developed at CISR primarily
as an approach to determine the information
requirements of managers. CISR has also been
a pioneer in studying executive support systems
(ESS) which provide computer-based support
for senior level managers. *The Rise of Manage-
rial Computing: The Best of the Center for
Information Systems Research*, edited by John
F. Rockart and Christine V. Bullen and pub-
lished by Dow Jones-Irwin in 1986, is a collec-
tion of CISR papers concerning the managerial
use of computing.

This past year, John F. Rockart and
David W. De Long completed a major research
project on executive support systems, and their
book, *Executive Support Systems: The Emer-
gence of Top Management Computer Use*, was
published by Dow Jones-Irwin. Their findings,
based on a field study of approximately thirty
large corporations, address how executive
support systems are being used to enhance
executive efficiency and cognitive processes
and to improve management control systems.
Other results identify the critical issues in ESS
implementation.

"Computer-supported cooperative
work" and "groupware" are two terms being
used to describe a recent emphasis in the area
of the managerial use of computers. The tradi-
tional DSS emphasis on supporting an individ-
ual manager is shifting to a focus of using
computer-based systems to support groups of
people working together. This support can be
synchronous (e.g., helping to focus brain-
storming during meetings) or asynchronous
(e.g., providing communications and docu-
ment support for geographically dispersed
project teams). CISR Working Paper No. 169 by
Christine V. Bullen and Robert Johansen pro-
vides an overview of the topic that categorizes
various groupware tools and suggests how
groupware can facilitate the work of business
teams.

Two other CISR researchers, Profs. Henderson and Malone, have projects under way related to the concept of group support. John C. Henderson is studying computer support for groups of cooperating experts. In the first phase of the research, he is observing how individuals on software design teams work together both with and without the support of computer-based tools. The objective of the research is to examine how technology can be used to improve the efficiency and effectiveness of teams of experts. An overall conceptual framework for the study of systems design, described in CISR Working Paper No. 158, provides a theoretical base for the research and highlights specific propositions to be explored. Also, an empirical study of eighteen I/S design teams has been completed and the preliminary results are in CISR Working Paper No. 164. This paper demonstrates that a distributed problem-solving model can be used to understand how organizational roles influence the design process. The study also suggests that the pattern of influence can predict the performance of the team. Further, the findings suggest that I/S design teams may vary in terms of their strategies for interacting with individuals and groups external to the team. Christine V. Bullen and James E. Short are working with Prof. Henderson on this study.



actions they may take on receiving messages. Part of this project involves the study of naturally occurring information sharing and coordination processes in the work of professional and clerical staff at a variety of field sites, both with and without electronic support. These field studies have provided a major source of ideas for designing the Lens system. CISR Working Paper Nos. 147 and 148 describe this project.

Understanding Key

Information Technologies

Research on information technology has also been a tradition at the Sloan School. The overriding purpose of many such projects has been to understand the technologies that can be brought to bear when implementing systems dictated by managerial needs.

Database technology has long been a major research area at CISR. Stuart E. Madnick, in conjunction with Amar Gupta and Hoo-min D. Toong, continues to lead the INFOPLEX database computer project. The project has five related goals: (1) develop and refine the database computer concept; (2) specify the software and hardware organization of a unique high-speed, high-reliability database computer; (3) identify new algorithms to be used and study their formal properties; (4) model INFOPLEX to assess its performance and operation; and (5) implement a prototype of the INFOPLEX system to demonstrate feasibility and operational characteristics.

Progress has been made on all five objectives with specific emphasis this past year on the development of formal proofs for the properties of algorithms proposed, especially hierarchical concurrency control and locality theory, extensions to the operational analysis approach to modeling complex queuing systems to incorporate the "flow unbalanced" nature of the INFOPLEX system, and research on various aspects of distributed heterogeneous database systems.

Another project led by Prof. Madnick building on his earlier research concerning technical integration. Today, many so-called strategic applications require interorganizational systems and/or more integrated intra-organizational systems. Prof. Madnick refers such systems as "composite information systems" and the research goal is to develop a framework for a comprehensive methodology for these large scale, distributed, heterogeneous information systems. CISR Working Paper No. 170, by Prof. Madnick and Y. Richard Wang of the University of Arizona, is one of several reports that describes the work done thus far.

John Henderson's research on I/S design teams encompasses a study of the types of functionality currently available in computer-aided tools for I/S planning and design. Based on interviews with leading design experts, this study identified six major categories of functionality addressed by CASE (computer-aided systems engineering) tools. Empirical analysis suggests that these functionalities can be used to differentiate current CASE products.

Knowledge-based systems have become a significant area of technology research at CISR. In conjunction with MIT's Artificial Intelligence Laboratory, Randall Davis continues to research this area by centering his work around three primary themes. The first is understanding and reasoning "how things work", and is concerned with capturing (and embodying in a program) the kind of reasoning based on knowledge of a device's structure and behavior that people use in a range of tasks, including diagnosing and designing engineered artifacts. The second theme involves understanding what comprises a "good representation". This is a core issue in AI because of the underlying assumption that selecting the right representation is the key to solving most problems. Prof. Davis and his students are designing a system that can take as input a verbal reasoning problem (like those in college entrance exams) and analyze it to determine what kind of representation and reasoning strategy would be best suited to that problem.



Much of Thomas W. Malone's research continues to focus on the problems involved in designing computer systems that help groups of people work together. Prof. Malone and his research team, which includes Keh-Chiang Yu and Kevin Crowston, have developed a prototype of an intelligent system for information sharing and coordination. This system, the Information Lens, uses artificial intelligence techniques to help users: (1) filter, sort, and prioritize electronic messages; (2) find useful messages or other documents they would not otherwise have seen; and (3) support common

hus, this project seeks to determine how one knows "what to pay attention to" when designing representations for use in a program.

The third theme in Prof. Davis' research involves developing methods for cooperative knowledge acquisition. There are two aspects to this important issue: (1) developing approaches to the construction of a single, consensus knowledge base that captures the expertise of more than one expert and (2) developing methods that allow a knowledge-based system to use multiple, distinct knowledge bases acquired from different experts.

Management of the Information Systems Function

Since the advent of commercial data processing, the role of information technology in organizations has changed dramatically. Information technology is being used to support not only the paperwork processes of the firm, but also management processes and, to a growing extent, the strategy of firms. The requirements of the information era are forcing rapid evolution in the management of the information systems function. Increasingly, I/S management is filling several key roles in the corporation. The I/S function must not only build and support the technological infrastructure of the firm, but must also support the needs of a growing number of sophisticated end users. I/S personnel must be ready to support line managers in their new roles as managers of technology. Finally, I/S is assuming a greater role in the development of corporate plans and strategy relating to the use of information technology.

Much of CISR's research has focused on managing the I/S function. Issues such as the decentralization of I/S, the changing role of the I/S executive, and human resource policy for the I/S function have been studied in the

past. Several projects have researched the management of end user computing.

One of John F. Rockart's research interests is the role of user managers in managing information technology. As part of this research, interviews have been conducted with several line managers who have assumed increased responsibility for the use of information technology in their organizations. As described in CISR Working Paper No. 160, the relationship between user departments and the I/S department is changing, and user management has a new role in selecting, justifying, designing, and implementing the systems which will support their departments.

Another major research effort that Dr. Rockart is leading is a study of the management of data. Judith A. Quillard and Dale L. Goodhue are also involved in this multi-year project. To learn more about effective approaches to "managing the data resource", CISR has conducted case studies of data management efforts in twenty diverse firms. The research focuses on the managerial motivations, planning processes, and types of output achieved. The findings reveal no single, dominant approach to improving the management of data. Rather, firms have adopted multiple approaches, contingent upon business needs. CISR Working Paper No. 159 summarizes the initial results. The current emphasis of the project is on three key topics: data-oriented planning; roles and responsibilities for managing data; and data architecture.

Software development management is a research focus for Stuart E. Madnick and Tarek K. Abdel-Hamid, who is at the Naval Postgraduate School in California. Using system dynamics techniques to model the software development process, the project is examining the implications of management policies on the various highly interdependent



facets of software development. The model is able to explain phenomena that have been reported in the literature on project management and also to predict the impact of proposed software management policies. A recent report based on this project is CISR Working Paper No. 163. A book, *The Dynamics of Software Project Management*, is scheduled for publication by Prentice-Hall in late 1988.

As part of his research to develop a theory of "coordination science", Thomas W. Malone is studying changes in organizational structure accompanying the use of information technology. His work in this area involves developing formal models of organizational structures and then using them to analyze or predict the effects of information technology. For example, in CISR Working Paper No. 137, with co-authors Robert Benjamin and JoAnne Yates, Prof. Malone focuses on how electronic markets and electronic hierarchies will allow closer integration of adjacent steps in the value-added chains of the economy. The most



surprising prediction from this analysis is that information technology may lead to an overall shift toward proportionately more coordination by markets rather than by internal decisions within firms. Several recent examples of industries (such as air travel reservations) where these changes are already occurring are used to illustrate the likely paths by which new market structures will evolve.

Prof. Malone is also interested in the parallels between human and computer organizations and has written two articles that formally define and analyze a set of generic coordination structures that appear in a wide variety of systems, including human organizations and computer systems. The four generic coordination structures are product hierarchies, functional hierarchies, centralized markets, and decentralized markets. Drawing primarily on queuing models, his analysis ranks these structures in terms of three performance measures: production costs, coordination costs, and vulnerability costs. The models show how changes in the values of these performance measures affect the desirabilities of the different structures.

Two projects under the direction of Michael E. Treacy are studying the organizational impact of information technology. The first is a study analyzing the effect of a personal computer and electronic mail system on a field sales force. A five-part model forms the basis for measuring system impact on the performance of the individual sales representatives. The parts of the model are (1) the system design; (2) use of the system; (3) changes in individual behavior and management processes; (4) performance against goals; and (5) direct economic value, i.e., changes in sales and market share. Measurement of system impact in each of these five areas will aid in determining the mechanism by which information systems affect performance.

In the second study, completed this year, Prof. Treacy and Soonchul Lee examined the impact of office information systems. As part of this project, users of successful office systems in a number of organizations were surveyed to assess how the performance of work had changed. The study focused on seven dimensions of group work: (1) efficiency of work; (2) group interaction and structure; (3) planning and control mechanisms; (4) influence and authority relationships; (5) innovation; (6) quality of the work life; and (7) group problem-solving ability. CISR Working Papers 154, 156, 159, and 162 report some of the results.

The impact of information technology on corporate strategy continues to be a significant research focus for Michael S. Scott Morton. His latest work in this area is on the topic of electronic data interchange (EDI), as a special class of interorganizational systems. An implicit assumption in the early literature on EDI was that these systems hold great potential for

providing competitive advantage. The research results presented in CISR Working Paper No. 166 suggest, however, that EDI applications, rather than being a strategic weapon, are increasingly a necessary way of doing business.

Chris F. Kemerer is also conducting research aimed at better understanding the software development process in order to increase the efficiency of software developers and improve the quality of the resulting product. To achieve this goal, Prof. Kemerer is working on four related projects. The first seeks to increase the accuracy of software development cost estimation. The second topic, which is discussed in CISR Working Paper No. 168, is the measurement of software development productivity and quality with an emphasis on whether increased productivity occurs only at the expense of high quality, or whether there are technologies that can simultaneously improve the efficiency and effectiveness of the software development team. Evaluating computer-aided software engineering (CASE) tools is the third topic. Prof. Kemerer is interested in the impact of learning curves on effective tool use and whether there are significant economies of scale that must be taken into account. Finally, the results from the above three areas will contribute to the fourth project which is the creation of testable models of software development. The intent is to use these models to explain the software development process and to predict the effects of new technologies and other process changes.

Jeffrey A. Meldman continues to track the comparative advantages and disadvantages of protecting computer programs by means of copyrights, patents, and trade secrets. He also continues to monitor the implications of privacy law for I/S management.

For a number of years, one of John C. Henderson's major research topics has been strategic information systems planning. With a project team that includes Prof. N. Venkatraman and Christine Bullen, Prof. Henderson is initiating a multi-phase research effort aimed at assessing the extent to which I/S planning leads to both increased investments in information technology and measurable business benefits. The approach for the study will be to evaluate actual strategic I/S planning efforts in terms of products, process, and outcome. As part of this evaluation, the study will analyze the effectiveness of alternate planning processes as viewed by key stakeholders, and the extent to which the planning process helped to establish a partnership between the I/S function and key line/staff functions.

Impact of Information Technology on Organizations

Another major focus at CISR concerns the impact of information technology on organizations. It is increasingly evident that information technology is now having major effect on organizational processes, structure, and managerial roles. Many management researchers believe that the typical large corporation of 1990s will look very different than it does today. The rise of so-called "information-based" organizations — companies with fewer layers of management coupled with increased integration of key, cross-functional business processes — will be closely linked to technology's ability to provide consistent, accessible, and timely information to all levels of the corporation. Clearly, the theme of "the interdependent organization", noted in the "Message from Director", is most evident in these CISR research projects with their primary emphasis on organizational impacts.

As noted in the "Message", John F. Rockart, James E. Short, and Christine V. Bullen are working on a major study that seeks to understand how firms can utilize information technology to both manage and exploit interdependencies which exist in organizations. Case studies are being conducted in several large firms. The interviews with managers document the changes that are occurring at the perceived reasons underlying the changes. Thus, this first phase of the study is descriptive. The second phase will be analytic, as the research team attempts to understand and describe the dominant trends in the cases. The planned third phase of the study will involve a broader sample of companies to attempt to document the evidence for these trends in a larger community of organizations.



SUMMER SESSION

holds an annual conference in June for information systems managers. At this Summer session, CISR faculty report on current trends and developments in the I/S field and present results of their own research. The conference format includes both general sessions to which all participants are invited and a series of smaller sessions for participants in the field of their major research efforts, and elective sessions which allow them to focus on particular areas of interest. The conference as a whole provides a forum where practitioners and researchers can discuss significant issues in the management of the information systems function.

The 1988 Summer Session, held June 23, was titled "Current Issues in Managing Information Technology: Enabling Organizational Change". A full enrollment of two hundred managers representing one hundred U.S. and forty foreign organizations attended. Specific presentation topics included:

- Changing External Environment: Implications for the Information Technology Function
- Information Technology's Impact on Organizations
- Strategic I/S Planning
- Strategic Role of Information Networks
- Managing Data as a Corporate Resource
- Expert Systems
- Managing End User Computing
- Dynamics of Software Project Management
- Using Information Technology for Work Group Coordination

- Executive Support Systems
- The Changing Role of the Information Systems Executive

The CISR Summer Session is designed for senior managers who head information systems functions in medium to large organizations in the public and private sectors. It is also relevant for other high level corporate and divisional I/S managers, especially those responsible for I/S planning, end user computing, and systems development. In addition, the program is of interest to non-I/S line and staff managers who are involved in decisions regarding the use of information technologies in their firms and who wish to improve their understanding of current issues and future trends.

The next Summer Session is scheduled for June 12-15, 1989. A brochure describing the program, and an enrollment application form, will be available in early April.

ENDICOTT HOUSE SEMINARS

This academic year, CISR held its twentieth Endicott House seminar. This series of two and one-half day seminars — so named because the meeting location is the Endicott House, a gracious mansion given to MIT many years ago — assembles our sponsoring organizations to discuss a single topic of interest to managers in the information systems (I/S) function. The seminars usually focus on actual practice presented by sponsors and others in case studies of current efforts. The cases and their implications are then discussed to formulate general guidelines for I/S practice and to identify research issues. These seminars have become an important part of the CISR program.



The title of the seminar held in April 1988 was "Integrating the New Organization: The Role of Information Technology". The focus of the session was on leading-edge firms who are utilizing information technology to enhance the coordination and integration of key business activities among dispersed operating units. The seminar was led by John F. Rockart who gave an overview of CISR's research project concerning the impacts of information technology on organizational structure, process, and managerial roles. The industry speakers included managers from Chemical Bank, Baxter Healthcare, IBM, and Westinghouse.

ONE DAY SEMINARS

The objective of CISR's series of one-day seminars is to give the participants in-depth exposure to both new and ongoing research. Depending on the program, we not only invite CISR sponsors, but occasionally open attendance to managers from other organizations. Three such seminars were held in the 87-88 academic year.

The seminar held in November 1987 assessed the role of expert systems in the I/S arena. Prof. Randall Davis spoke about issues that corporations face as they undertake expert systems efforts. Speakers from Du Pont, American Express, and Digital Equipment Corporation presented the experiences of their firms in developing expert systems for business applications. The discussion emphasized the key factors in implementing such systems.

In March 1988, Prof. John Henderson led a seminar on "The Value of Strategic Information Systems Planning". Presentations from two companies described the contrasting approaches which they had taken to strategic I/S planning. In discussion, the attendees probed the organizational reasons behind the success of each. Prof. Michael Scott Morton ended the day by examining the purpose and value of strategic planning in general.

"Groupware: Tools for Managing Business Teams" was the title of the May 1988 seminar led by Christine Bullen and Robert Johansen. Two years ago, CISR held a seminar on the same topic that focused on defining the area and reporting on research and experimental systems. This year's groupware seminar





emphasized user experiences, given that there are now products in the marketplace and organizations with some experience utilizing these tools to facilitate the work of business teams. Through a mix of formal presentations, panel sessions, and open discussion, the seminar probed the value of groupware by exploring the benefits and problems users have seen.

In addition, CISR sometimes holds "special interest group" meetings as part of the research process. The aim of these one-day sessions is to facilitate discussion among a small group of managers who are actively working on a particular issue.

This past year CISR held two "special interest group" meetings on the topic of data resource management (DRM). In October 1987 and January 1988, ten managers whose companies have active DRM programs met to share their experiences. The first meeting focused on data architectures and the second on roles and responsibilities for the data management function. These issues are two of the areas being emphasized by CISR's current DRM research.

TEACHING PROGRAMS

The MIT Sloan School of Management offers master's, doctoral, and executive education programs, and MIT undergraduates may elect to major in management science. The management information systems (MIS) courses at Sloan are taught by the faculty listed in this report. The MIS curriculum covers such areas as introduction to information systems; key aspects of technology (e.g., database systems, expert systems, and telecommunications); issues in information systems management; decision support systems; and legal issues related to information systems.

Information regarding the master's programs may be obtained by contacting:

Dr. Jeffrey Barks
Associate Dean for Undergraduate and
Master's Programs
Room E52-112B
Telephone: 617-253-3747

Inquiries regarding the Ph.D. program may be directed to:

Ms. Sharon Cayley
Ph.D. Program Coordinator
Room E52-122F
Telephone: 617-253-7188

Those interested in the executive development programs, which include the Sloan Fellows Program and the Senior Executive Program, should contact:

Mr. Alan F. White
Associate Dean for Executive Programs
Room E52-126B
Telephone: 617-253-7166

Correspondence may be sent to:

Massachusetts Institute of Technology
Sloan School of Management
50 Memorial Drive
Cambridge, MA 02139

On occasion, CISR's faculty members either direct or present research at special seminars held at MIT for managers and professionals. The seminars are taught during the summer months, and are one to two weeks in length. Information about these seminars may be obtained from:

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CISR Working Paper Series is an important vehicle for dissemination of research results, its viewpoints, and progress reports on projects and programs under investigation. The papers in this series have been written by the author and other researchers associated with CISR. Listed here are the most recent papers. Complete lists of the Working Paper Series, order forms, and subscription information are available by writing to CISR. In 1986, collection of nineteen CISR papers was published by Dow Jones-Irwin in a book, *The Rise of Managerial Computing: The Best of the Year for Information Systems Research*. The book is available in bookstores and from CISR.

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166	The Realities of Electronic Data Interchange: How Much Competitive Advantage?	Benjamin De Long Scott Morton	1/88
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148	Semi-Structured Messages are Surprisingly Useful for Computer-Supported Coordination	Malone et al	11/86
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146	A Microcomputer-Based Image Database Management System	Prasad Gupta Truong Madnick	11/86
145	The Value Added of Strategic IS Planning: Understanding Consistency, Validity, and I/S Markets	Henderson Solomon	11/86
144	Cognitive Science and Organizational Design: A Case Study of Computer Conferencing	Crowston Malone Lin	11/86
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125	Formulating Explicit Executive Models for Planning and Control	Treacy	6/85

Other Articles and Books

Listed below are books and a number of other papers published by the Center's faculty and staff during the academic year:

Abdel-Hamid, T.K. and Madnick, S.E. "On the Portability of Quantitative Software Estimation Models," *Information & Management*, Vol. 13, No. 1, August 1987.

Crowston, K., Malone, T.W., and Lin, F. "Cognitive Science and Organizational Design: A Case Study of Computer Conferencing," *Human-Computer Interaction*, Vol. 3, No. 1, 1986-1987, reprinted in *Computer Supported Cooperative Work*, I. Greif (ed.), Morgan Kaufmann, Los Altos, California, 1988.

Davis, R. "Knowledge-based Systems: The View in 1986," in *AI in the 1990s and Beyond*, Grimson and Patil (eds.), MIT Press, Cambridge, Massachusetts, 1987.

Davis, R. "Knowledge-based Systems as Decision Aids: What Have We Got? What Do We Need?" in *Impact and Potential of Decision Research on Decision Aiding*, Tolcott and Holt (eds.), Report of an ONR Sponsored Department of Defense Research Roundtable Workshop, December 1987.

Frank, W.F., Madnick, S.E., and Wang, Y.R. "A Conceptual Model for Integrated Autonomous Processing: An International Bank's Experience with Large Databases," *Proceedings of the Eighth International Conference on Information Systems*, Pittsburgh, Pennsylvania, December 1987.

Henderson, J.C. and Sifonis, J.G. "The Value Added of Strategic I/S Planning: Understanding Consistency, Validity and I/S Markets," *MIS Quarterly*, Vol. 12, No. 2, June 1988.

Kemerer, C.F. "An Empirical Validation of Software Cost Estimation Models," *Communications of the ACM*, Vol. 30, No. 5, May 1987.

Kemerer, C.F., Banker, R., and Datar, S. "Factors Affecting Software Maintenance Productivity: An Exploratory Study," *Proceedings of the Eighth International Conference on Information Systems*, Pittsburgh, Pennsylvania, December 1987.

Lee, S. and Treacy, M.E. "The Impact of Information Technology on Control: A Leadership Theory Perspective," *Proceedings of the Eighth International Conference on Information Systems*, Pittsburgh, Pennsylvania, December 1987.

Madnick, S.E. (ed.) *Planning for the Strategic Use of Information Technology*, Oxford University Press, New York, 1987.

Madnick, S.E. and Wang, Y.R. "A Framework of Composite Information Systems for Strategic Advantages," *Proceedings of the 21st Hawaii International Conference on Systems Sciences*, Kailu-Kona, Hawaii, January 1988.

Madnick, S.E. and Wang, Y.R. "Integrating Disparate Databases for Composite Answers," *Proceedings of the 21st Hawaii International Conference on Systems Sciences*, Kailu-Kona, Hawaii, January 1988.

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Malone, T.W. "Modeling Coordination in Organizations and Markets," *Management Science*, Vol. 33, No. 10, October 1987.

Malone T.W. "Computer Support for Organizations: Toward an Organizational Science," in *Interfacing Thought: Cognitive Aspects of Human-Computer Interaction*, Carroll, J.M. (ed.), MIT Press, Cambridge, Massachusetts, 1987.

Rockart, J.F. "The Line Takes the Leadership," *Sloan Management Review*, Vol. 29, No. 4, Summer 1988.

Rockart, J.F. and De Long, D.W. *Executive Support Systems: The Emergence of Top Management Computer Use*, Dow Jones-Irwin, Homewood, Illinois, 1988.

Theses

Every academic year, a number of master's and doctoral candidates write their theses under the guidance of the CISR faculty or research staff. The master's students may define their own thesis topics or may participate in formal "structured" thesis projects. A representative list of these completed during 1987-88 is given below.

Bain, J.S. "Managing Automation in the Financial Services Industry: Three Case Studies on the Use of Service Level Agreement Systems."

Bakos, J.Y. "Interorganizational Information Systems: Strategic Implications for Competition and Cooperation."

Dawson, S.G. "Commercialization Expert Systems for Real-time Applications."

Goodhue, D.L. "Supporting Users of Corporate Data: The Effect of I/S Policy Choices."

Kennedy, R.E. "Systems Integration the Life Insurance Industry."

Kershner, S.K., Mankoff, S.M., and Pastoriza, J.J., Jr. "A Critical Success Factors Application to Falcon Microsystems, a Federal Market Distributor."

Lin, F. "Modeling Complex Organizational Coordination Processes: A Case Study Engineering Change Processing."

Nash, L.S. "The Use and Management of Information Technology in Multinational Companies."

Parikh, A.S. "Strategic Impact of Communication Networks on the Financial Services Industry."

Phillips, M.W. "The Impact of Electronic Mail and Computer Conferencing: A Case Study."

Pumarada O'Neill, M.E. "The Impact of CASE Technology on Information Systems Design Using Parallel Teams: A Case Study."

Siderius, J.H. "Hospital Information Systems."

Sosa, G.L. "The Potential Pitfalls in the Conceptualization, Development and Implementation of Strategic Information Systems."

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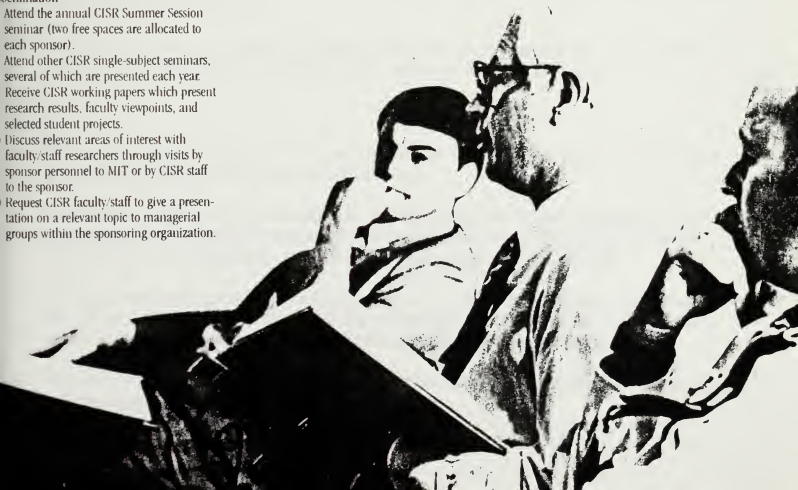
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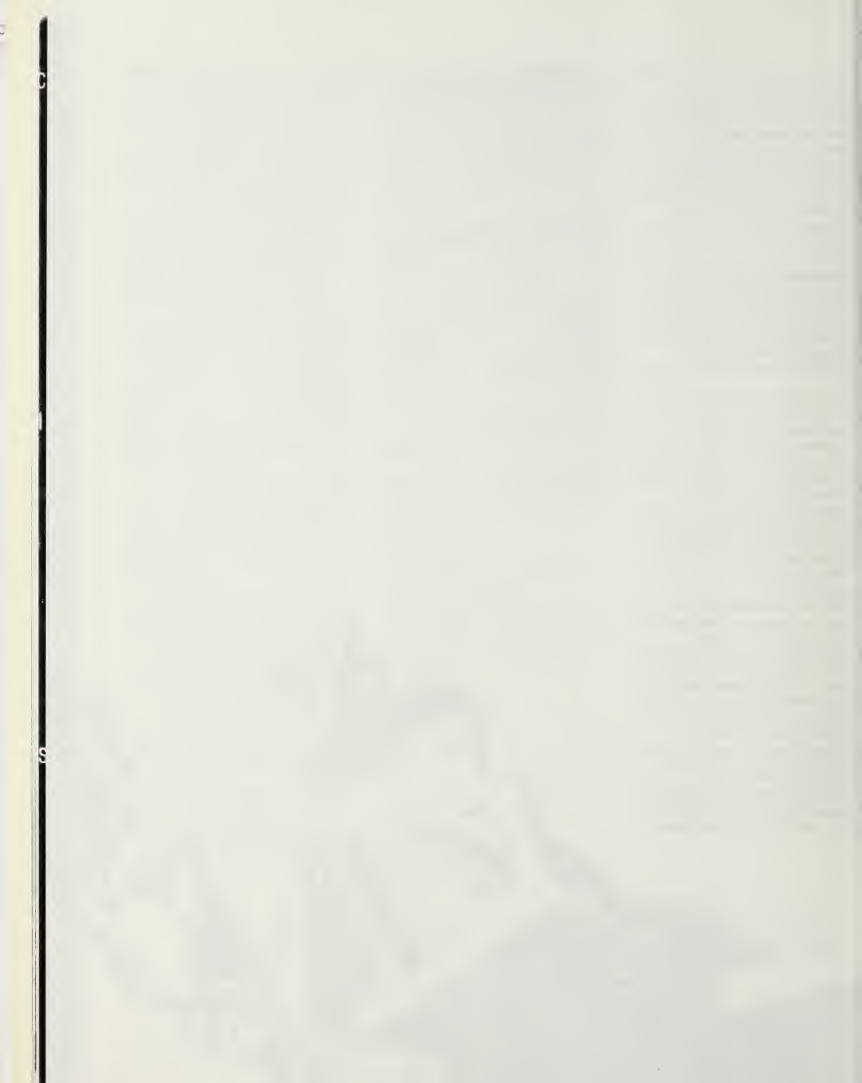
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1989-1990

Recruiting

- Continue to use CMI facilities and personnel to demonstrate the College's interdisciplinary approach during recruiting of prospective faculty and students or the building of external business or research alliances.

Research

- Refine the system for handling the Working Paper series, increasing the number of contributors and making information about the collection more widely available.
- Coordinate the linking of various locally networked sites for further research in the area of group support being done by faculty and students in various departments in the College.

Instructional

- Offer more varied series of computer classes expanding out into different levels of expertise and different applications coordinating these activities with the instructional computing group of CCIT.
- Provide additional, portable technological support for use in classroom instruction. (Decent cart with portable units and new version of Kodak Datashow)

Service

- Work with outside vendors, CCIT and the campus bookstore to increase accessibility of educationally discounted programs for students.
- Organize an expanded format computer fair for the students and employees of the university with representatives of software and hardware vendors and including a concurrent set of workshops on information technology related subjects.
- Provide additional equipment and operating environments to include a Macintosh based lab for use in support of coursework and courseware development as well as several specific research projects within the MIS and Accounting departments
- Provide a centralized service organization for handling the maintenance of College microcomputers and peripherals.

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June, 1989

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- WPS-88-02 Vogel, Douglas R., Nunamaker, J.F., George, Joey F., Dennis, Alan R. "Group Decision Support Systems: Evolution and Status at the University of Arizona." MISCS A.4.1, March 1988.
- WPS-88-03 George, Joey F., Northcraft, Gregory B., and Nunamaker, J.F., Jr. "Implications of Group Decision Support System Use For Management: Report of a Pilot Study." MISCS A.4.1, April 1988.
- WPS-88-04 Cohen, Yeshayahu "Rethinking Prototype Classifications." MISCS A.3.7, May 1988.
- WPS-88-05 Kaku, Bharat K. and Rachamadugu, Ram "Layout Design for Flexible Manufacturing Systems." MISCS A.6.1, August 1988.
- WPS-88-06 Marsten, R.E., Saltzman, M.J., Shanno, D.F., Pierce G.S., Ballintijn, J.F. "Implementation of a Dual Affine Interior Point Algorithm for Linear Programming." MISCS A.6.1, August 1988.
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- WPS-88-08 Dennis, A.R., George, J.F., Nunamaker Jr., J.F., Vogel, D.R. "Automated Support For Group Work." MISCS A.4.1, September 1988.
- WPS-88-09 Carmel, E., Herniter, B.C. "MEDIANNs: Conceptual Design of a System for Negotiation Session." MISCS A.4.1, September 27, 1988
- WPS-88-10 Synder, J.M. "Eastern European Attempts to Clove the VAX." MISCS B.6., C.7., September 27, 1988.
- WPS-88-11 Sheffield, Jim "Seeing's Believing and Body Language is the Truth: A Comparison of Negotiation Outcom in Decision Room and Computer Conferencing Communication Media." MISCS A.4.1, October, 1988
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- WPS-88-19 Aiken, Milam W., Motiwalla, Luvai F., Sheng, Olivia R. Liu, Nunamaker, Jr., Jay F. "An Expert Systems Approach to Group Decision Support Systems: Tool Selection." MICSC A.4.1, C.6.1.1, C.6.2.1. February, 1989.

- WPS-88-20 Anderson, Russell, Ram, Sudha "Benchmarking Database Management Systems for End-User Computing." MISCS A.3B, C.1&4 February, 1989.
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- WPS-88-31 Beranek, Margaret M., Vogel, Douglas R., and Nunamaker, Jay F. "Object-Oriented Database Design for Executive Information Systems: Conceptual Model and Prototype." MISCS ?????? June, 1989.

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- WPS-87-10 Vogel, Doug, Konsynski, Benn, and Nunamaker, Jay F., Jr. "Key Issues in Operationalizing Group Support Systems: Directions for Research", MISCS A.41, 1987, will submit to Management Science.
- WPS-87-10 Sheng, Olivia R. Liu "Database Allocation in Ethernet-Based Local Area Networks: A Queuing Analytic Approach," MISCS C.21, 1987.
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- WPS-87-15 Heltne, Mari M., Vinze, Ajay S., Konsynski, Benn R., and Nunamaker, Jay F., Jr. "A Consultation System for Information Center Resource Allocation." MISCS A.3.B, appear in the Rising Tide of Business Expert Systems, 23rd Annual Conference, March 5-6, 1987.
- WPS-87-16 Sheng, Olivia R. Liu and Higa, Kunihiko "A Structured Approach for Relational Database Development." MISCS C.12, August 1987.
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- WPS-87-30 Ram, Sudha and Marsten, Roy E. "Design of Distributed Database Systems Incorporating Concurrency Control." MISCS C.18, 1987.
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- WPS-85-03 Vogel, Doug and Wetherbe, J. "Office Automation: Research Model Development and Validation." MISCS A.51, June 1985.
- WPS-85-04 Vogel, Doug, Lehman, J., and DeSanctis, G. "Business Graphics: Determinants of Satisfaction." MISCS C.4.A, July 1985.
- WPS-85-05 Vogel, Doug, Roger, C. and Wetherbe, J. "A Survey of MIS Organizational Structures." MISCS A.10, October 1985.
- WPS-85-06 Wang, Richard Y., Nunamaker, Jay F., Chen, Minder, "KAPLEX: A Software Architecture for Knowledge-based Authoring Systems." MISCS C.61, December 1985.
- WPS-85-07 Chang, Alex and Motiwalla, Luvai "Communication Scripts for the Computer Based Messaging Systems." MISCS C.21, November 1985.
- WPS-85-08 Wysk, Rudiger B. "Automation of Factory and Office Operations: A Comparison of Strategies." MISCS A.51, May 1985.
- WPS-85-09 Wysk, Rudiger B. "Information Systems Planning Processes: The Case of the Banking Industry." MISCS A.31, December 1985.
- WPS-85-10 Wysk, Rudiger B. "Office Information Systems: Integration and Benefits." MISCS A.50, March 1985.

[1984]

- WPS-84-01 Balas, Egon and Saltzman, Matthew J. "Some Facets of the Three-index Assignment Polytope." MISCS A.61, Oct. 1984.
- WPS-84-02 Zeldin, Paul and Nunamaker, J.F., Jr. "An Expert System for Hardware Configuration Based on Workload Profiles." MISCS C.61, C.51, 1984.
- WPS-84-03 Higa, Kunihiro "Methodological Approach to a Recursive Algorithm." MISCS C.31, November 1984.
- WPS-84-04 Motiwalla, Luvai F. "The Impact of Distributed Computer Systems on Auditors in DBMS Environments." MISCS C.18, May 1984.
- WPS-84-05 Konsynski, Benn R., Motiwalla, Luvai F., Azarnia, R. and Reichel, J. "Comparison of Software Alternatives in Micro Environments." MISCS C.50, October 1984.
- WPS-84-06 Motiwalla, Luvai F. and Konsynski, Benn R. "On Authoring Mail Drivers for the MASH System." MISCS C.20, November 1984.
- WPS-84-04 Wysk, Rudiger B. "Selection of DSS Generators: An Annotated Bibliography." MISCS A.42, May 1984.

WPS-84-05

Wysk, Rudiger B. "Information Systems and Business Strategy: Customer Orientation in Financial Services." MISCS B.L0, May, 1984.

WPS-84-06

Wysk, Rudiger B. "Information Systems and Organizational Design: The Impact of Interorganizational Systems." MISCS B.L0, August 1984.

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Center for Research on Information Systems

Annual Report
1988



Center for Research on Information Systems

Leonard N. Stern School of Business
New York University
90 Trinity Place
New York, N.Y. 10006

INTRODUCTION

The Center for Research on Information Systems at New York University's Leonard N. Stern School of Business is dedicated to the support of innovative research in Information Systems. Its goal is to strengthen ties between academic research and industry for their mutual benefit. The Center provides not only channels for funding support, but access for industrial partners to research results, students, and innovative educational programs.

This report describes the Center's activities during the academic year from September 1987 through August 1988. It demonstrates the Center's dedication to innovation in information systems and to research and educational activities. We invite you to read this report and to let us know your reactions. We would particularly like to know how the Center might play a role in improving your organization's channels of communication with academic research and educational programs.



A Letter From The Director

The Center for Research on Information Systems has played a central role in the Information Systems Area at NYU for nearly a decade. When I became Director in September 1986, I took over a thriving organization with a highly active Corporate Affiliates Program and an outstanding program of innovative research.

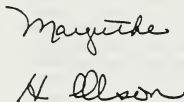
The greatest strength of the Center is our faculty who are dedicated to both research and teaching. We have seventeen full-time faculty plus over twenty-five active Ph.D. students and several visiting scholars. Our research output, described in this report, is prodigious, innovative, current and broad-based. Our faculty tackle practical problems, whether in highly technical areas of computer science or organization problems in information technology and management strategy. Our highly diversified faculty collaborate on projects requiring an interdisciplinary focus. Thus several projects require the combined expertise of faculty in artificial intelligence, database, organization behavior, corporate strategy, sociology, cognitive psychology, operations management, and operations research.

This report describes the innovative, collaborative research projects in which our faculty are currently engaged. It also describes a critical component of our center, the Corporate Affiliates Program. Through this program, faculty share research results and receive valuable feedback on their implications for industry practice. The link to industry provided by the Affiliates Program is critical to keeping our research focused and practical.

In October 1988, our school officially became the Leonard N. Stern

School of Business. Exciting changes are taking place at the Stern School. In 1992 we plan to move to a new building on the Washington Square campus. This year, Henry C. Lucas, Jr. was awarded a Stern School Research Professorship.

We look forward to 1989 at the Stern School as a time for sustaining innovative research in information systems as well as our Affiliates Program.



Margrethe H. Olson
Director, Center for Research on
Information Systems
Associate Professor of Information
Systems



A Letter From The Chairman

The major event this year was the generous grant from Leonard N. Stern—one of the largest donations ever to a business school. This gift will allow us to build a state-of-the-art educational facility at Washington Square thus consolidating our undergraduate and graduate programs at one site. It also gives us an unprecedented opportunity to rethink our educational programs "from the bottom-up." This process has already begun.

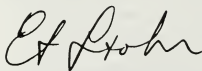
Education in information systems has been driven by advances in technology and by the introduction of new theories from the disciplines of computer science, artificial intelligence, management science and behavioral science. But information systems professionals also need a broad range of knowledge in managerial as well as technical areas. Our strong faculty with its broad range of technical and managerial research interests places us in an ideal position to provide this broad-based and innovative education in information systems.

Over the last three years, we have undertaken a major revision of the curriculum for the information systems major in the undergraduate and graduate programs. We are identifying a core of information systems related knowledge that must be known by all our majors. We see the information systems discipline resting on a foundation of knowledge in technology, systems development techniques, and management theory. Our students must apply this knowledge to the analysis, design, and management of the total information architecture of an organization. In the M.B.A. program, we are also introducing courses that introduce students to the fundamentals of

information systems designed to serve particular functional areas such as finance, marketing and operations management.

The Leonard N. Stern School of Business is constantly improving our computing services for students. An "electronic classroom" developed with the aid of a major equipment grant from the Panasonic Corporation has allowed us to introduce new methods for delivering computer-based instruction. Next year, our PC laboratories will be enhanced by the addition of a number of powerful, state-of-the-art workstations.

Finally, I want to thank the members of the CRIS Advisory Board and the representatives of our affiliated companies for many fruitful discussions on both research and curriculum issues. Their participation and guidance have contributed greatly to both our research and teaching programs.



Edward A. Stohr
Chairman, Information Systems
Department
Associate Professor of Information
Systems



A Letter From The Affiliates Program Director

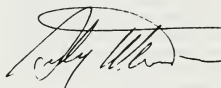
During this past year, the Affiliates Program has again grown in its number of companies; there are now seventeen major companies in the program. There has also been a growth in the number of seminars and other activities that constitute the program.

The seminars, developed primarily from suggestions from our annual Affiliates Roundtable participants and the Affiliates Advisory Board, were extremely well attended. The program for the coming year consists of a mix of technical and managerial topics with sufficient variety and timeliness to interest both top management and technical participants.

Our annual Careers Night Program and Alumni Night provided a unique opportunity for students, affiliates and alumni to meet. Company representatives at Careers Night receive resumes of both graduate and undergraduate students. The internship and summer employment pro-

grams have also been of interest to both students and affiliates.

We hope our future efforts will continue to provide opportunities for the exchange of ideas between the Center and affiliates companies.



Sidney Weinstein
Director, Affiliates Program
Center for Research on Information
Systems



CRIS ACTIVITIES AND ACCOMPLISHMENTS

The past academic year has been a very busy and productive one for the faculty and Affiliates.

CRIS Affiliates Program

The Affiliates Program has prospered under Affiliates Director Sidney Weinstein. The mission of the Affiliates Program is to forge strong links between the academic research of our faculty and the real problems faced by organizations by (1) providing industry with direct access to University research and teaching programs; (2) developing opportunities for collaborative research; (3) establishing a channel of access between students and prospective employers for part-time, summer, and full-time employment.



Affiliates Seminar Series

The Seminar Series is the central focus of our Affiliates Program. It provides the opportunity to hear and interact with leading experts in the information systems field. Perhaps more important, it gives Affiliates members the opportunity to meet and share their ideas about important issues.

Speakers in the 1987-88 academic year included:

- Carl Hammer, Computer Scientist, "Transition To Procedural Processing"
- David Shpilberg, Coopers & Lybrand, "Knowledge Based Information Systems: The Upcoming Marriage of Artificial Intelligence and Software Engineering"
- Bob Mark, Marine Midland Bank, "Financial Trader's Workstations"
- William L. Hooton, National Archives & Records Administration, "Computer Imaging"
- Bob Benjamin, Xerox Corporation, "The Future of the Information Systems Profession"
- Robert Chartrand, Library of Congress, "Disaster Recovery — Emergency Preparedness"

The Affiliates Program also sponsors an annual Careers Night, an opportunity for Affiliates to meet students and for students to learn about careers in information systems. In May, the Affiliates Program holds the annual Information Systems Roundtable, a discussion with Affiliates and faculty on important issues in information systems.

CRIS Research Seminar Series

CRIS also sponsors the Research Seminar Series, which draws speakers from other universities and research institutions to discuss their current research. Each visitor spends a day meeting with faculty members and graduate students who are conducting similar research.

Some of our speakers in the past year's Research Seminar Series were:

- Herb Spier, University of Connecticut
- Abe Jaffe, Columbia University
- Sirkka Jarvenpaa, University of Texas at Austin
- Tora Bikson, The Rand Corporation
- Boaz Ronen, New York University and Tel-Aviv University
- Steven Alter, University of San Francisco

Symposium Series

Each spring, the Center holds a two-day symposium on a topic in which current research and the needs of the practitioner community are beginning to merge. The title of this year's symposium was "Information Technology and Securities Markets Under Stress." The speakers and topics were:

- Kalman J. Cohen, Duke University and Robert A. Schwartz, New York University, "Realizing the Potential of an Electronic Trading System"
- Yakov Amihud, New York University and Haim Mendelson, University of Rochester, "Liquidity, Volatility and Exchange Automation"
- J. Pearce Bunting, Toronto Stock Exchange, "Moving from Today's to Tomorrow's Trading System"
- Roger Kubarych, New York Stock Exchange, "The Market's Response to October 19th"
- Robert A. Wood, Pennsylvania State University, "Survival Strategies for Exchanges"
- Anne E. Allen, New York Stock Exchange, "The Display Book: The NYSE Specialists' Electronic Workstation"
- Robert Riess, National Association of Securities Dealers, Inc., "NASDAQ: Experience with Pioneering an Electronic Market"
- Michael Newman, London Stock Exchange, "Qualities of Markets: The London Experience"
- Paul G. Stevens, American Stock Exchange, "How the AMEX Processed the Load"

- Robert Van Kirk, Securities Industry Automation Corp., "How SIAC Survived"
- Frank T. Coyle, National Association of Securities Dealers, Inc., "The NASDAQ Experience"
- Peter B. Madoff, Bernard L. Madoff Investment Securities, "The Systems: The User's View of the Impact of the Events of October"
- James French, Wellington Management Company-Thorndike, Doran, Paine, Lewis, "The Efficiency of Computer Systems Under Stress – A View from an Institutional Trading Desk"
- John T. Wall, National Association of Securities Dealers, Inc., "Formal Links among Exchanges"
- Junius W. Peake, Peake/Ryerson Consulting Group, Inc., Morris Mendelson, The Wharton School of the University of Pennsylvania, and R.T. Williams, Jr., R. Shriver

Associates, "Black Monday: Market Structure and Market Making"

- Eric Clemons, The Wharton School of the University of Pennsylvania, "Global Competition in Corporate Capital Markets"
- James L. Hamilton, Wayne State University, "Electronic Market Linkages and the Distribution of Order Flow: The Case of Off-Board Trading of NYSE-Listed Stocks"
- Franklin R. Edwards, Columbia University, "The Crash: A Report on the Reports"
- Fischer Black, Goldman, Sachs & Company, William J. Broadsky, Chicago Mercantile Exchange, Richard G. Ketchum, Securities and Exchange Commission, Richard A. Grasso, New York Stock Exchange, and Susan M. Phillips, University of Iowa, "Information Technology and Market Volatility"



The following is a list of previous symposia and the resulting publications:

- 1987 *Technological Support for Work Group Collaboration*. Margrethe H. Olson, ed. Hillsdale, NJ: Lawrence Erlbaum & Associates, 1989. (Available from publisher.)
- 1986 *Information Technology and Management Strategy*. Jon A. Turner and Kenneth Laudon, eds. Englewood Cliffs, NJ: Prentice-Hall, 1988. (Available from publisher.)
- 1985 *Managers, Micros and Mainframes: Integrating Systems for End Users*. Matthias Jarke, ed. London: John Wiley and Sons, 1986. (Available from publisher.)
- 1984 *New Directions for Database Systems*. Gad Ariav and James Clifford, eds. Norwood, NJ: Ablex Publishing Co., 1984. (Available from publisher.)
- 1983 *Artificial Intelligence Applications for Business*. Walter Reitman ed. Norwood, NJ: Ablex Publishing Co., 1984. (Available from publisher.)
- 1982 *Human Factors and Interactive Computer Systems*. Yannis Vassiliou, ed. Norwood, NJ: Ablex Publishing Co., 1984. (Available from publisher.)
- 1981 *Decision Support Systems*. Michael J. Ginzberg, Walter Reitman, and Edward A. Stohr, eds. Amsterdam: North-Holland Publishing Co., 1982. (Available from publisher.)
- 1980 *Distributed Processing Practice*. (Available from Center for Research on Information Systems.)
- 1979 *Automated Office Systems*. (Available from Center for Research on Information Systems.)
- 1978 *Database Design*. (Available from Center for Research on Information Systems.)

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AWARDS AND SPECIAL EVENTS

Henry C. Lucas, Jr. was appointed the Research Professorship in Information Systems, Stern School of Business.

Professor Claudio Ciburra of Universite di Trento was a Visiting Professor for a semester. His work on IS and transaction cost theory stimulated a great deal of interest among the faculty and Ph.D. students.

Professor Robert Kauffman joined the faculty as an Assistant Professor. Rob recently completed his Ph.D. at Carnegie-Mellon University under the advisement of Professor Charles Kriebel.

Professor Shimon Schocken won the 1987-1988 ICIT (International Center for Information Technologies) Doctoral Dissertation Award for the best dissertation written in 1987-1988 in the information systems field. Shimon's thesis, "On the Underlying Rationality of Non-Deterministic Rule-Based Inference Systems," will be published as a book by ICIT Press.

Professor Kenneth Laudon was awarded a National Science Foundation (NSF) Grant; the topic: "National Information Systems Computer Impacts."

Professor Edward Stohr won an NSF grant to support an international workshop on "Information Systems and Decision Processes."

Professor Jon A. Turner received a University Curriculum Challenge Grant to prepare a "living case" using information technology.

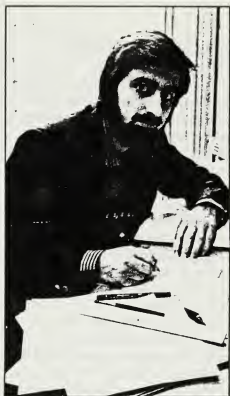
COMPLETED RESEARCH

The seventeen full-time faculty and twenty-five Ph.D. candidates affiliated with the Center are all pursuing applied research, much of it in cooperation with Affiliates member firms. In this section our research accomplishments for the 1987-88 academic year are highlighted, including relevant publications. Requests for reprints of published papers may be directed to the Center.

Automated Support for Formulating Mathematical Models

Most research in Management Science has been concerned with efficient algorithms for solving operations research problems in the form of mathematical programming models. Given the success of this research and the power of modern computers, the major impediment to more widespread use of models is the difficulty in formulating them and in interpreting the results they produce.

A major research effort in the Center involves the development of an intelligent system to help users formulate and manage large and complex linear programming models. The team has developed an object-oriented, graphical representation that allows nonmathematical users to specify and modify linear programming models. The system supports several problem-solving strategies such as hierarchical decomposition, multiple representations, and reusability of previously defined sub-models. A laboratory experiment to test the system using Ph.D. student subjects gave very favorable results. We are now attempting to extend the approach to a broader range of modeling techniques.



Publications:

Ma, P., F.H. Murphy and E.A. Stohr, "Design of a Graphics Interface for Linear Programming," *Communications of the ACM* (forthcoming).

Ma, P., F.H. Murphy and E.A. Stohr, "Representing Knowledge about Linear Programming Formulations," *Annals of Operations Research* (forthcoming).

Ma, P., F.H. Murphy and E.A. Stohr, "Computer Assisted Formulation of Linear Programs," *IMA Journal of Mathematics in Management* (1987).

Stohr, E.A., "Automated Support for Formulating Linear Programs," *Proceedings, NATO ASI: Mathematical Models for Decision Support*, Val D'Isere, France (August 1987).

Ma, P., F.H. Murphy and E.A. Stohr, "Composition Rules for Building Linear Programming Models from Component Models," *CRIS Working Paper #148* (1987).

Artificial Intelligence and Expert Systems

A Planner's Assistant. Developing business plans in a large organization is complex and involves many individuals. Firms often use formal planning models to generate detailed projections of the resources required. These projections, called "resource plans," constitute a planning model. However, when expectations change, firms need a method to systematically change the underlying assumptions and the structure of the resulting models.

Research was conducted with a large computer manufacturer to develop a "planner's assistant" called PLANET; the system permits systematic variation in a model's underlying assumptions, resulting in corresponding changes in the resource plan. When previously held beliefs prove unjustified, the program reconceptualizes the problem and accounts for the changed assumptions. A large manufacturing firm is adopting a prototype of PLANET as a planning tool.

The PLANET architecture has been enhanced into a general modeling environment that allows decision makers to express knowledge about any domain from which qualitative and quantitative models can be synthesized. This new project is described briefly in the "Research Work in Progress" section of this report.

Publications:

Dhar, V. and H. Pople, "Rule-Based Versus Structure-Based Models in Explaining and Generating Expert Behavior," *Communications of the ACM*, 30, No. 6 (1987).

Dhar, V., "On the Plausibility and Scope of Expert Systems in Management," *Journal of Management Information Systems*, 3, No. 3 (1987).

An Auditor's Assistant. Auditing firms are interested in knowledge-based systems to support audit planning. Knowledge-based systems can help auditors with the systematic assessment of risk and the formulation of audit plans based on risk. Professor Dhar has been studying audit planning in two "big eight" accounting firms. He has modeled the process of risk assessment as a "knowledge-based" exercise that involves understanding the effects of a variety of economic and organization-specific factors on accounts. The knowledge pertains to the client's history, recent events specific to a firm; all are crucial in shaping the auditor's judgement about risks associated with accounts, and hence the audit plan. For large accounts, the auditor must be confident that the risk of making an erroneous decision is low. Given the increased competitiveness of the auditing profession, however, the auditors are limited in terms of resources assigned to each client. Good planning is therefore essential for an efficient audit; before beginning information gathering and substantive testing, the auditor must have expectations about specific general ledger accounts that might be particularly risky and plan tests accordingly.

The first phase of this research resulted in a prototype knowledge-based system to assess the inherent risk associated with accounts. The system has recently been field tested. Professor Dhar is currently evaluating auditors' critiques of the system and modifying it to overcome its current limitations.

Publications:

Dhar, V., B. Lewis and J. Peters, "A Knowledge-Based Model of Inherent Risk," *AI Magazine*, 9, No. 3 (Fall 1988).

A Modeling Environment to Support Constraint-Based Reasoning. Many business decisions require choices from competing alternatives based on qualitative and quantitative constraints. The decision process can be viewed as one of *design*, consisting of a related set of choices. Existing modeling systems are of limited value because of their inability to represent the range of constraints involved in many business problems. The PLANET system, which was designed to support planning problems in a manufacturing context, was geared to overcome limitations of existing modeling systems. In subsequent work, Professors Dhar and Croker have implemented a generalized domain-independent constraint-based reasoning model. In this model, constraints and assumptions that occur in many decision situations can be expressed and reasoned. The knowledge expressed in this model can also be linked explicitly to spreadsheet and project management modules.

Publications:

Dhar, V. and A. Croker, "Expert Systems in Business: Issues and a Solution," *IEEE Expert*, 3 (1988).

Uncertainty and Belief. Commercial expert systems are expected to cope with uncertain field data, inexact inference rules, and subjective expert opinions. The challenge of dealing with these uncertainties in a computer program has led to the development of several "belief languages" which are widely used in existing expert systems. Ongoing research by Professor Shimon Schocken investigates the rational justification and feasibility of these models. This research consists of analyzing the mathematical, cognitive, and com-

putational aspects of rule-based inference under uncertainty. The ultimate goal is to propose and test credible models for eliciting and propagating degrees of belief in the context of rule-based reasoning.

Publications:

Schocken, S., *Uncertainty Management in Expert Systems*, ICIT Press, forthcoming (1989).

Schocken, S., "On the Rational Scope of Probabilistic Rule-Based Inference Systems," *Uncertainty in Artificial Intelligence*, J.F. Lemmer and L. Kanal (eds.), North-Holland (1988).

Schocken, S., "A Framework for Comparative Analysis of Belief Revision Models in Rule-Based Expert Systems," *Proceedings of the 22 Hawaii International Conference on Computer Science* (January 1989).

Schocken, S., "The Objective, Logical, and Subjective Views of Uncertainty: A Decision Support Perspective," *Proceedings of DSS-88*, Boston, MA (1988).

Schocken, S., "Ratio-Scale Elicitation of Degrees of Belief," CRIS Working Paper #188 (1988).

Schocken, S., "Putting the Validity of Rule-Based Inference Under Uncertainty to the Test: an Experiment," CRIS Working Paper #187 (1988).

Database Management Systems

Time and Databases. Although database management systems that are based on the relational data model have met with great commercial success, this success has led to a realization of certain deficiencies of the model. The relational data model is essentially a record-based system, and does not easily lend itself to applications that require a more general representation capability. Ongoing work in the Center focuses on improving the representation capability of relational database systems as well as the use of the more recently proposed object-oriented systems for overcoming the deficiencies of the relational data model.

One shortcoming, the lack of support for the temporal dimension of data, has been the focus of considerable attention in CRIS. The dissertations of Professors Clifford and Ariav represent the first serious research in this area, and the term "historical databases," coined by Professor Clifford in a landmark article, has become the accepted name for the field. Since this pioneering work in 1983, over 100 articles have been published in this growing area of research interest. One branch of the project in CRIS has explored user needs for temporal data management and incorporated them into a formal extension of the relational data model. The Historical Relational Database Model (HRDM) has been the result of these efforts. Recently, this work has led to a project to define a general theory of "consistent extensions" to the relational model of data.

Publications:

Clifford, J. and A. Croker, "On Post-Relational Database Management Systems," *Journal of Management Information Systems* (forthcoming).

Clifford, J. and A. Croker, "Objects in Time," *IEEE Data Engineering*, 11, No. 4 (1988), pp. 11-18.

Croker, A. and J. Clifford, "On Completeness of Historical Relational Data Models," CRIS Working Paper #192 (1989).

Clifford, J. and A. Croker, "The Historical Relational Data Model (HRDM) and Algebra Based on Lifespans," *Proceedings of the Third International Conference on Data Engineering*, Los Angeles, CA (February 1987).

Clifford, J., "Historical Databases: It's About Time!," CRIS Working Paper #168 (1987).

Clifford, J. and A. Rao, "A Simple, General Structure for Temporal Domains," *Proceedings of the Conference on Temporal Aspects in Information Systems*, Sophia - Antipolis, France (May 1987).

Ariav, G., "Design Requirements for Temporally-Oriented Information Systems," *Proceedings of the Conference on Temporal Aspects in Information Systems*, Sophia - Antipolis, France (May 1987).

Ariav, G., "Temporally Oriented Information Systems for Managerial Planning and Control," CRIS Working Paper (forthcoming).



Natural Language Database Access. The goal of an ongoing project in natural language database querying is to develop a theory to facilitate portable, extendable, and verifiable systems for accessing a database using English. A framework for such a theory has been developed, as well as a small database query language fragment (QE-III) within this theoretical framework. A parser for QE-III was implemented in UNIX FRANZ LISP. QE-III extends Montague Semantics with a semantic theory of questions and provides a new treatment of the pragmatic component of a formal language.

Publications:

Clifford, J., "Natural Language Querying of Historical Databases," *Computational Linguistics*, 14, No. 4 (Fall 1988).

Clifford, J., *Formal Semantics and Pragmatics for Natural Language Querying*, Cambridge University Press, (forthcoming, 1989).

Concurrent Database Usage. It is often necessary to allow several users to access a database simultaneously. However, because problems arise from simultaneous access, the number of users is often limited or response times increase significantly. A current project investigates techniques to increase the number of users that can simultaneously access a database while protecting its integrity.

Publications:

Crocker, A., "Improvement in Database Concurrency Control with Locking," *Journal of Management Information Systems*, 4, No. 2 (1987).

Management of the Information Systems Function

Implementation. The implementation of systems has become an even more important topic of research given changes in technology. Organizations are often choosing dedicated packages as an alternative to the custom design of a system. Professor Lucas has just completed a study of the package program implementation process in a sample of firms.

As more end-users work with computers, it is important to understand what factors and implementation strategies lead to successful systems. It is embarrassing and detrimental to the organization if an important system is not used due to implementation problems.

Implementation research can also answer questions about the impact of technology on its users and the organizations that develop systems. Plans are to extend the long history of implementation research at NYU with longitudinal studies of professionals using microcomputer-based workstations.

Publications:

Lucas, H.C., Jr. and Eric Walton, "Implementing Packaged Software," *MIS Quarterly*, 12, No. 4 (December 1988), pp. 534-537.

Managing Data Processing Personnel. Professor Baroudi has recently completed several studies on the management of data processing staff. The first study explored the extent to which job-related ambiguity and job-related conflict led to job dissatisfaction and turnover of programmers, analysts and project leaders. Study results indicated that information systems professionals are very intolerant of ambiguity. Job-related ambiguity was extremely dysfunctional.

tional, having a very strong relationship with both job dissatisfaction and intentions to quit. Job-related conflict, while problematic, was not nearly as troublesome.

A second study concerned how the technological environment faced by programmers and analysts affects turnover, job satisfaction and commitment to the organization. The variables investigated include (1) development methodologies, (2) project team organization and (3) type of work (maintenance versus development, batch versus online). The results indicated that these variables have major effects on how programmers and analysts feel about their jobs and their companies.

A third study investigated the organizational and individual consequences of mismatching individual career desires with organizational career options. The results showed that dual career paths may not meet the needs of those people desiring a technical career.

Publications:

Ginzberg, M. and J. Baroudi, "MIS Careers—A Theoretical Perspective," *Communications of the ACM*, 31, No. 9 (1988), pp. 586-594.

Baroudi, J., "The Dual Career Path: Does it Meet the Needs of IS Personnel?" *Proceedings of the 21st Annual Hawaii International Conference on System Sciences*, Honolulu (January 1988).

User Information Satisfaction. The goal of this project was to develop a method to quickly yet effectively determine if users are satisfied with the information systems they use. The researchers developed a thirteen-item questionnaire which asks users to evaluate the usefulness and accuracy of the information output they receive, the quality of the data processing staff and services, and the adequacy of training and user involvement in system development. The working paper referenced below provides examples of how to use the questionnaire and user satisfaction scores from 26 companies.

Publications:

Baroudi, J. and W. Orlowski, "A Short Form Measure of User Information Satisfaction: A Psychometric Evaluation and Notes on Use," *Journal of MIS*, 4, No. 4 (1988), pp. 44-59.

Work Redesign. For over twenty years, people have speculated about the consequences computers have for workers; would they lead to deskilling of jobs and a significant reduction in the number of positions available, or would they result in expanded opportunities? Ongoing research by Professor Turner focuses on models of computer-mediated work and using them to explain some of the factors that contribute to employee stress.

One study sponsored by the Office of Technology Assessment (US Congress) considered how an integrated office system was used by a major commercial bank to overcome a severe internal communications problem and gain a competitive advantage. The case analysis describes the business setting, the system, the changes that occurred in a variety of organizational functions including job content, patterns of communication and performance.



Another study tested the proposition that psychosomatic stress problems associated with the use of computer systems in offices result from the redesign of work associated with these systems rather than from interaction with the actual "physical" system itself. This proposition was tested with samples of mortgage loan servicing clerks and financial investment officers in 78 mutual savings banks. Workers in structured jobs making more intense use of computer systems were found to have poorer working conditions than those making less use of computer systems. Implications for productivity, quality of working life, job design, human resources management and systems development were discussed.

A related study focused on the organizational conditions associated with employee burnout among public service lawyers. Results indicated that burnout is indeed associated with specific job conditions and is also significantly related to organizational commitment.

Publications:

Jackson, S.E., J.A. Turner and A.P. Brief, "Correlates of Burnout among Public Service Lawyers," *Journal of Occupational Behavior* (1987).

Telecommuting as an Organizational Work Option. A series of studies, sponsored by the National Science Foundation, have recently been completed on telecommuting as an organizational work option. The premise of the project was that information technology frees up certain constraints on where and when organizational work, particularly office work, must be performed. There has been much speculation that information technology would permit jobs to be done at home and, therefore, telecommuting would become commonplace.

One part of this project surveyed organizational experiments with employees working at home—with three pilots evaluated over a six-month period. The conclusion was that, while work at home is technically feasible today, there is considerable resistance to it, primarily from supervisors rather than employees. Organizational culture is strong and requires that employees be "on-site" in order to be considered part of the organization.

In surveys of computer professionals, the surprising conclusion was that while many computer professionals work at home with computers, on average ten hours a week, they do not substitute work at home for going to a regular work place. Having a computer in the home may actually encourage a significant amount of unpaid overtime among computer professionals.

The conclusion from the studies is that telecommuting as an organizational work option will not become commonplace in the near future. However, more and more employees will work together while geographically separated, forming "remote work groups" and introducing new dilemmas in "remote supervision."

Publications:

Olson, M.H., "Telework: Practical Experience and Future Prospects," *Technology and the Transformation of White Collar Work*, R. Kraut (Ed.), Hillsdale, NJ: Lawrence Erlbaum Associates, Inc. (1987).

Olson, M.H., "An Investigation of the Impacts of Remote Work Environments and Supporting Technology," CRIS Working Paper #161 (1987).

Economic Analysis of Information Technology (IT) Impacts

Despite the many popular press articles which address questions about how IT impacts should be measured, there is still no consensus among researchers and managers about how to proceed. The objective of this research is to develop methods for the assessment of IT impacts, using the theory base of microeconomics and marketing science. One project focused on the development of metrics for competitive efficiency to describe the productivity relationship between IT investments and other major firm-level expenditures, and bottom line impacts, such as revenues, profitability and return on assets.

Another project looked at how metrics for operational efficiency should be constructed, to provide a means to gauge how IT affects micro-level environments in a firm. This is where management efforts to fine tune operations are centered, so it makes sense that IT performance measures should relate directly to the operations the IT is meant to support. A third focused on developing metrics for the operational and competitive effectiveness of IT. Here, the emphasis is on measuring the marginal economic impact of an IT investment, for example, in terms of labor savings, revenue gains or market share improvements.

Publications:

Banker, R.D. and R.J. Kauffman, "A Scientific Approach to the Measurement of IT Business Value—Part I: A Manager's Guide to 'Business Value' Linkage Impact Analysis," CRIS Working Paper #194 (October 1988).

Kauffman, R.J. and C.H. Kriebel, "Modeling and Measuring the Business Value of Information Technology," *Measuring the Business Value of*

Information Technologies, edited by CIT Research Study Team #2, ICIT Press, Washington, D.C. (July 1988).

Kauffman, R.J. and C.H. Kriebel, "Identifying Business Value Linkages or Production Processes Involving Information Technology," CRIS Working Paper #182, forthcoming in *Advances in Working Capital Management*, Y. Kim and V. Srinivasan (Eds.), JAI Press (1989).

Banker, R.D., R.J. Kauffman and R.C. Morey, "Measuring Input Productivity Gains from Information Technology," CRIS Working Paper #196, forthcoming in *Proceeding of the ACM Workshop on the Value and Impact of Information Technology*, Minneapolis, MN (May 1989).

Retail Payment Network Investment Evaluation

A series of projects conducted by Professor Kauffman looked at the effectiveness of investments in retail payment network technologies, including automated teller machines (ATMs) and point-of-sale (POS) debit systems. The results of this work suggest that a major economic impact of ATM network membership may be the leverage created to enable a bank to increase or protect deposit market share. The first study suggests a methodology to quantify this hard-to-measure impact. The second study extends the results of the first, by showing how to quantify service quality associated with ATM services. The third study shows how ATM network business value can be enhanced or suppressed by factors present in a bank branch's demographic and competitive environ-

ments. The final study in this series extends the modeling approach utilized for measuring ATM network leverage on deposit market share to POS debit technology in gasoline retailing.

Publications:

Banker, R.D. and R.J. Kauffman, "Strategic Contributions of Information Technology: An Empirical Study of ATM Networks," *Proceedings of the Ninth International Conference on Information Systems*, Minneapolis, MN (December 1988).

Banker, R.D. and R.J. Kauffman, "A Scientific Approach to the Measurement of IT Business Value - Part II:

A Case Study of Electronic Banking Operations at Meridian Bancorp," CRIS Working Paper #195 (October 1988).

Kauffman, R.J., A. Ghosh and A. Bansal, "Parameter Non-Stationarity in a Model Which Estimates the Business Value of Information Technology," CRIS Working Paper #197, forthcoming in *Proceedings of the ACM Workshop on the Impact and Value of Information Technology*, Minneapolis, MN (May 1989).

Kauffman, R.J., C.H. Kriebel and P.C. Zajonc, "Measuring Business Value for Investments in Point-of-Sale Technology," CRIS Working Paper #193 (December 1988).



Information Systems Ph.D. Research

The Doctor of Philosophy degree is awarded for scholarly attainment and represents the highest honor that the University may bestow on a student. After completion of the program, most Ph.D.s seek a career in research and teaching in universities, government or private industry. In 1988, seven doctoral students completed their dissertations and accepted positions at universities or research institutions. Their dissertations are briefly described here. Professor Jon A. Turner is Coordinator of the Doctoral Program.

Completed Ph.D. Dissertations:

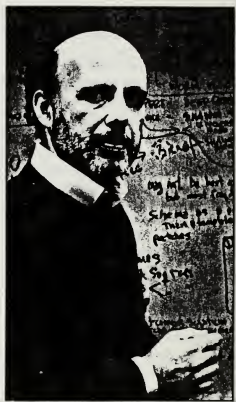
Ajay Asthana: "LPGRAPH: An Expert Assistant for Graphically Formulating Linear Programs." The goal of this thesis was to develop a graphical, knowledge-based support environment to support linear programming (LP) formulation. The thesis is divided into three parts: a graphical language, AI support environment, and empirical evaluation. Ajay took a position as a Research Associate with Arthur Andersen & Company.

Linda Jo Calloway: "An Approach for Assessing Tools for Designing Dialog Structures: A Study of the Dialog Charts." The dialog component of an interactive human/computer system provides the communication between user task requirements and system functions. This dissertation constructs a qualitative research methodology aimed at discovering a set of categories and relationships that characterize usage of design tools for dialogs and applies the assessment methodology to a target tool, the Dialog Charts (Ariav & Calloway, 1988). The research methodology uses empirical

information derived from a field experiment with teams of designers who used the target tool while developing interactive systems. Linda Jo is presently an Assistant Professor at Fordham University.

Sue Conger: "An Exploration of Information Technology Use for Inter-Unit Coordination." This research develops a theory of information coordination which integrates the MIS and organization literature to evaluate the factors that influence the selection of coordination methods. The results of this study show that many more methods of coordination are used than previous research has indicated, and that methods are used differently by different tasks types. Task characteristics are related to the use of coordination methods. Simple, stable tasks use more memos, policies, wires, facsimiles, applications and data bases. Difficult, variable tasks use more meetings, telephone conversations, audio conferencing and electronic messaging. Sue is presently an Assistant Professor at Georgia State University.

Pai-chun Ma: "An Intelligent Approach to Formulating Linear Programs." Linear programming (LP) is the best known and most widely used optimization technique in industry and the military. The complexity of LP real-world models makes their formulation and interpretation an error-prone and time-consuming task. The object of this research is to improve these processes. A graphical, object-oriented representation of LP models was implemented. Users formulate their models using an iconic representation to depict transportation networks, factories, inventories, and general LP activities. Pai-chun is an Assistant Professor at the University of Delaware.



Ken Marr: "Error Correction in Data Entry: A Cognitive Based Model of a Routine, Highly Practiced Computer Mediated Task." This research addressed the problem of error creation by studying the dynamics of user-system interaction and first effect on user accuracy using the task of data entry. A controlled experiment was conducted in which the timing of error messages was varied and operator speed and accuracy were measured. Results indicate that the timing of error notification messages plays an important role in total user performance. Ken is currently an Assistant Professor at Hofstra University.

Wanda Orlikowski: "Information Technology in Post-Bureaucratic Organizations." This research

RESEARCH WORK IN PROGRESS

explored fundamental changes in the control strategies and work of organizations as information technology becomes their core technology. Two main issues were explored: the role of information technology in the development of post-bureaucratic organizational control strategies; and the influence of social, political and cultural processes in shaping the nature and use of information technology in organizations. An eight-month ethnographic study of a large software consulting firm was conducted. This firm has automated its service delivery procedure—the development and installation of computer-based systems for clients, via the use of CASE (Computer-Aided Software Engineering) tools, and it is this technology that was the focus of the research. Wanda is currently an Assistant Professor at the Sloan School of Management, MIT.

Peter Weill: "The Relationship between Investment in Information Technology and Firm Performance in the Manufacturing Sector." Enormous amounts of resources have been and continue to be invested in information technology (IT), but there is very little convincing evidence that investments in IT are actually economically advisable. This study presents a model to assist in understanding the mechanism of IT investment, and empirically tests the model in a sample of firms in the manufacturing sector. The study provided evidence of the relationship between investment in IT and firm performance. Peter is now a senior lecturer at the Graduate School of Management, Melbourne University.

Artificial Intelligence Applications in Business

Application of artificial intelligence to problems in business constitutes a continuing CRIS research project. Despite the flurry of interest in business applications, few successful expert systems have been developed in the business domain. A major characteristic of the business domain is the need for cooperative, interacting agents that bring disparate types of knowledge to bear on a problem. Among the current topics being pursued are the application of the Center's historical database work, coupled with a temporal reasoning component based on expert system technology, to a problem in financial analysis. Another project concerns constraint-based reasoning to support generic business problems such as long-range project planning and resource allocation.

In another study, a research team is developing a system for a specialist at the American Stock Exchange. The system, called AESOP (An Expert for Stock Options Pricing), will assist the specialist in moving from the theoretical option price based on a well-known financial model to the actual bid and ask prices posted on the exchange floor. The system will apply the specialist's rules which necessitate a deviation from the model's theoretical recommendations, rules from such sources as the requirements imposed by the limit order book, spread orders and the specialist's own position in the option and stock.



Database Management Systems

Pioneering work on extending today's database management systems to handle data over time is of ongoing research interest. Among the questions addressed are criteria for assessing the completeness of extensions proposed both by CRIS researchers and others. We are also exploring a generalization of our model for the time dimension to allow for the handling of data with multiple points of view. Among the kinds of information our model will handle are opinions, expectations, judgments, personal observations, histories, predictions, expert advice, hypothesized scenarios, design versions, and simulations. Another ongoing project investigates the merging of the formalisms of the relational model with generalized representation capabilities of object-oriented database systems.

Modeling Information Processing

Professor Sasso is continuing development of a consistent approach to constructing GPSS-based simulation models of information processing, given descriptions of these processes based on the Task Analysis Methodology, and the development of broad, useful and reliable coding schemes for the classification of information-processing activity. Complementing this theoretical work is a series of empirical studies that compare the conceptual models with actual information-processing activity in organizations. The first of these, a case study of a leasing firm, proposes a hierarchy of levels of information-processing success, ranging from "maintains a physical environment in which hardware will operate," to high levels such as "anticipates the business plan in order that enabling information systems will be in place when required." It is predicted that higher levels of success presuppose that the lower levels have already been satisfied.

Decision Support Systems

Research extending earlier work on decision support systems is supported by the National Science Foundation and examines how potential users of a decision support system choose between alternative information sources. This research should result in guidelines for the design and implementation of decision support-systems. The research should also provide a better understanding of how decision makers choose their sources of information.

A related project examines the organizational and environmental factors that affect successful implementation of software packages and will identify the best tools to facilitate successful implementation.

The setting of the study is a group of manufacturing firms that all use a particular computer vendor's production planning and control package. Data are being collected from the vendor's marketing representatives and from several employees of each firm.

Another project looks at methods for DSS analysis and design to develop guidelines for matching methodologies and decision situations. Typically, efforts in this domain have dealt with a single methodology for DSS development, under the implicit premise that there is only one DSS development methodology. Our approach recognizes that different decision situations call for different approaches to DSS analysis and design. A DSS developer has to select an appropriate methodology from the pool of available DSS development methodologies, and the primary basis for this selection should be the salient characteristics of the decision situation under study. The research constructs a topology of design methodologies for DSS's, and develops a program to identify experimentally the nature of the decision situations where a given methodology could be effective.

Systems Analysis and Design

The objective of this research is to improve understanding of the nature of the information systems design process. A great deal has been written about how information systems *should* be developed, but relatively little empirical research has shown which techniques do, in fact, reduce the cost and/or improve the quality of the resulting information system. This research seeks to capture descriptions of systems designers in action, and to identify the alternative patterns of design activity which they apply. If these patterns vary sys-

tematically with the designers' expertise, we can use these findings to improve both educational technique and practice in information systems design.

Impact of Information Technology on the Organization

A major project funded by the National Science Foundation involves a thirty-year retrospective study of information technology management and utilization at three of the largest domestic policy federal agencies: Social Security Administration, Internal Revenue Service, and Federal Bureau of Investigation. The variables in the study are: changing occupational composition of the labor force, productivity changes, investments in information technology, political and policy environment changes, internal politics, and bureaucratization.



Technological Support for Collaborative Work Groups

Several ongoing projects consider how people work together and the ways in which technology might support collaboration. One project focuses on group decision making, particularly when work group members are not in the same place or cannot meet at the same time. A system must allow for communication among group members (e.g., computerized conferencing and electronic mail), and should support both individual members and the group as a whole. A prototype system has been constructed on a personal computer network. Extensions of the project involve development of models to support multiple-criteria decision making and negotiation when noncooperation among participants is the norm.

A second project involves observation over time of members of a research and development laboratory who are building tools to support work group collaboration. The group, physically split into two geographically separate locations, is concerned with supporting remote collaboration. The research involves observation of how organizational culture is transmitted over time and space.

A third project involves a longitudinal case study of a management-level planning team in a major computer vendor. The purpose of the project is to understand coordination needs (both intra-unit and inter-unit) of an "entrepreneurial" management team, in order to design management support tools that meet their coordination requirements.

Living Case

Professor Jon Turner has received an NYU Challenge Fund Grant for evaluation of his Living Case method of instruction. The Living Case is a computer-aided system that is an alternative to traditional methods of case instruction. Rather than reading a case, a student interacts with a computer system during information gathering, problem identification, and action planning phases of case analysis and thus learns through exploration. Not only does this create a potentially more interesting learning environment, but it also permits data gathering on student behavior during case analysis that may lead to insights into the process of learning.

Distance Metrics for the Effectiveness of IT Business Value Measures

One of the basic theoretical problems which has yet to be properly addressed by the literature on measuring IT impacts is how to determine whether a set of performance measures is well-suited to capturing the impacts of a particular IT. In this research, a framework is being developed which attempts to predict measure effectiveness based on the concept of "distance" between an investment and an impact. A manager's problem is where to "locate" the measures that will be used, i.e., at the locus of investment, the locus of impact, or somewhere in between. The expected result of this work is a means to identify how to "position" a measurement system to provide a maximum amount of useful information.



THE INFORMATION SYSTEMS FACULTY

Edward A. Stohr, Associate Professor and Chairman
B.S., Melbourne University, Australia; M.B.A., Ph.D., University of California (Berkeley), School of Business. Systems analysis and design, decision support systems, expert systems.

Henry C. Lucas, Jr., Research Professor
B.S., Yale University; Ph.D., Massachusetts Institute of Technology, Sloan School of Management. Organizational context of systems, implementation, expert systems, information systems and corporate strategy.

Kenneth C. Laudon, Professor
B.A., Stanford University; Ph.D., Columbia University, Graduate School of Arts and Sciences. Information systems planning and policy, auditing systems, social and organizational impacts of computer systems.

Myron Uretsky, Professor
B.B.A., City University of New York,
City College; M.B.A., Ph.D., Ohio
State University, Graduate School of
Business Administration. Privacy,
transfer of computer technology,
technology planning, management
gaming.

Jack Baroudi, Associate Professor
B.S.B.A., Boston University; Ph.D.,
New York University, Stern School of
Business. Management of systems
personnel, information processing
environment, implementation,
behavioral science theory.

James Clifford, Associate Professor
B.A., Yale University; M.S., Ph.D.,
SUNY (Stony Brook), College of
Engineering and Applied Science.
Database management, natural
language interfaces, logic, expert
systems.

Vasant Dhar, Associate Professor
B. Tech., Indian Institute of Technol-
ogy; Ph.D., University of Pittsburgh,
Graduate School of Business. Artificial
intelligence, cognitive science,
expert systems, organization theory.

Margrethe H. Olson, Associate
Professor
B.S., University of Michigan;
M.B.A., Ph.D., University of Minne-
sota, School of Management. Impact
of systems on individuals, organiza-
tions, and society; technological sup-
port for work groups.

Jon A. Turner, Associate Professor
B.S., Yale University; M.S., Ph.D.,
Columbia University, Graduate
School of Arts and Sciences.
Organizational behavior, systems
analysis and design, impact of sys-
tems on work life, job design, infor-
mation systems policy and strategy.

Norman H. White, Clinical Associate
Professor
B.A., Harvard University; Ph.D.,
New York University, Stern School of

Business. Decision support systems,
office automation, computer
graphics, information processing
technology.

Gadi Ariav, Assistant Professor
B.A., M.Sc., Tel-Aviv University;
Ph.D., University of Pennsylvania,
The Wharton School. Information
technology, database management
systems, user interfaces.

Albert E. Croker, Assistant Professor
B.S., M.S., Ph.D., SUNY (Stony
Brook), College of Engineering and
Applied Science. Concurrency con-
trol, database semantics, distributed
databases, relational database theory.

Barry Floyd, Assistant Professor
B.S., Michigan State University;
Ph.D., University of Michigan,
Graduate School of Business
Administration. Human-computer
communication, information system
design, management of information
systems, human factors, user
interfaces.

Robert J. Kauffman, Assistant
Professor
B.A., University of Colorado,
Boulder; M.A., Cornell University;
M.S., Ph.D., Carnegie Mellon Uni-
versity, Graduate School of Industrial
Administration. Economic analysis of
IT impacts, information economics,
IS and corporate strategy, and man-
agement science for the financial
services industry.

Irina Neuman, Assistant Professor
B.A., Academy of Economic Sciences,
Bucharest; M.S., Ph.D., University of
Rochester, Simon Graduate School of
Business Administration. Computer
communications networks, distributed
databases, combinatorial optimization.

William C. Sasso, Assistant
Professor
B.S., University of Chicago; M.B.A.,



University of Illinois; Ph.D., Uni-
versity of Michigan, Graduate School of
Business Administration. Design and
implementation of office systems,
simulation and modeling, research
methodology.

Shimon Schocken, Assistant
Professor
B.A., Hebrew University of Jerusa-
lem; M.B.A., Indiana University;
M.S.A.E., Ph.D., University of Penn-
sylvania, The Wharton School. Deci-
sion making under uncertainty,
knowledge acquisition, decision
science, cognitive psychology.

Visiting Faculty

Claudio Ciorra, Visiting Associate
Professor
M.S., Politecnico di Milano. Informa-
tion system design, work group sup-
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5	An Investigation of Data Base Requirements for Institutional and Ad Hoc DSS	Garnto Watson	6/85	26	A,P
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7	The Issue of Data Administration	Carr	6/85	11	A,P
8	End-User Computing and General Systems Theory	Carr	6/85	20	P

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11	Training End Users: An Exploratory Study	Nelson Cheney	11/85	28	A,P
12	Educating the CBIS User	Nelson Cheney	12/85	18	P
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15	Charging for Information Center Services	Carr	4/86	12	P
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17	Factors that Affect User-Friendliness in Interactive Computer Programs	Brannen Carr	5/86	19	A,P
18	The Management Information and Decision Support (MIDS) Systems at Lockheed Georgia	Houdeshel Watson	6/86	27	A,P

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21	Critical Success Factors for Information Center Managers	Magal Carr Watson	11/86 1/87 (Revised)		A,P
22	An Investigation of The Effects of Age, Size and Hardware Option on the Critical Success Factors Applicable to Information Centers	Magal Carr	2/87	27	A,P
23	What is the Best User-to- Staff Ratio for an Information Center?	Carr	2/87	7	P
24	On Capacity Management Theory	Blackstone	9/87	18	A,P
25	Assessing the Utility of Computer- Generated Graphics in Problem Solving	Miles O'Keefe Hatfield Huseman	8/87	31	A

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27	Organizational Support for Decision Support Systems	Watson Lipp Jackson Dahmani Fredenberger	Rev. 10/88	35	A,P
28	Information Systems Personnel Requirements: 1978 & 1987	Cheney Lipp	6/88	28	A,P
29	The Implications of Using Computer- Based Surveys for Research	Carr	9/88	10	A,P
30	It Takes A Champion	Carr Hogue	9/88	6	P
31	Factors That Affect User- Friendliness in Interactive Computer Programs	Brannen Carr	9/88	30	A,P
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33	Career Paths To, In, and From the Information Center	Rainer Frolick Carr	9/88	22	A,P
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36	End User Computing-- Auditor Beware?	Jackson Carr	10/88	12	P
37	The Importance of Learning Style in End-User Training	Bostrom Olfman Sein	12/88	28	A
38	Successful Application Techniques to Improve the Systems Development Process	Bostrom	1/89	36	A,P
39	A Case for Collaborative Work Support Systems in a Meeting Environment	Bostrom Anson	2/89	35	A,P
40	Using Computerized Collaborative Work Support Systems to Improve the Logical Systems Design Process	Bostrom Anson	2/89	45	A,P

Brief Descriptions of the Working Papers

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Description

- 1 The concept of examining the relationship between differential skill profiles and job performance is integral to many professions. In this paper, we present an overview of skill categories in the MIS field, followed by an examination of MIS job positions. A conceptual model for study in this area is then presented. The model has narrowed the numerous MIS job titles into four broad classes which are slotted into six skill categories. A relative skill level is established for each job title. A methodology is presented for the empirical validation of the model. The model is intended as an organizational tool for current and potential IS personnel to assess the "best" mix of skills for specific IS positions.
- 2 This paper focuses on knowledge engineering in order to conceptualize an expert system application. A prototype environmental scanning expert system is developed and discussed in terms of its advantages and limitations.
- 3 IBM created the information center concept in 1974 as a formal way to support end user computing. Since that time many organizations have adopted this organization of user support. This research reports the results of a study of 20 successful information centers and compares their organization with the IBM/Hammond model.
- 4 Organizations needing to develop computer-based applications have three alternatives: (1) formal development; (2) end user development; and (3) prototyping. No one of these options is singularly correct and there is a valid question as to which method is appropriate for any given application. This paper discusses the question of choosing among these alternatives.
- 5 Four decision support systems, two institutional and two ad hoc, were investigated. Of primary interest was whether there were differences in the data base component of the institutional and ad hoc DSS. The study's findings suggest that there are differences with practical implications for DSS designers.

Description

- 6 DSS research has largely ignored the evaluation of organizational units doing DSS work. This paper reports the findings of a study which explored evaluation variables and procedures for DSS groups. The study suggests the importance of multiple perspectives in evaluation and identifies evaluation variables relevant to these perspectives. Recommendations are made for evaluating DSS groups by matching evaluation variables with appropriate evaluation techniques.
- 7 The value of data administration and management is well known and the practice is assumed to be widespread. This paper reports practices of MIS organizations in 20 large firms and notes that although database technology is in high use, data administration is not.
- 8 This paper addresses end user computing from a general systems viewpoint. It attempts to show that end user development is a system and is a part of the greater DP/MIS system of the organization. The two methodologies complement one another and cause conflict.
- 9 This paper defines the concept of an Information Systems Research Center (ISRC) as having four characteristics: (1) it is administered by a College of Business; (2) its research focuses on business applications; (3) it facilitates formal linkages between the practitioner and academic communities; and (4) it is multi-project and multi-sponsor oriented. Ten ISRC's were compared as to their objectives, structure, curriculum, research and activities.
- 10 This paper attempts to identify those variables that affect the success of end user computing within an organization. The variables are classified as controllable, partially controllable or uncontrollable. Previous research on end user computing is reviewed, and several propositions relating organizational variables to the success of end user computing are suggested.
- 11 This study examined the relationship between information systems training and (1) the computer abilities of IS users, (2) systems use, and (3) user information satisfaction. The study involved 100 middle and top level managers at 20 companies which

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- had been identified as having a strategic dependence on their existing computer-based information systems.
- 12 Deficiencies in computer-related education for end users have contributed to the lack of successful integration of computer-based information systems into organizations. This paper describes the computer related training activities in four companies with unique approaches to the education of their user community.
- 13 Research in management information systems takes place, and is reported in three ways: (1) private studies that usually result in published articles; (2) doctoral dissertations; and (3) private or government funded research that may be reported in private publications. This article reviews all MIS related dissertations from 1973 to 1985.
- 14 This paper reports on the need for an instrument to measure computer user abilities and then discusses an attempt to develop and evaluate one such instrument. The instrument was tested for reliability and validity. Three ability factors were identified: (1) technical abilities; (2) modeling abilities; and (3) application oriented abilities.
- 15 It is believed that the practice of charging for all computer services is the norm and is appropriate. This research study of 20 large corporations indicates that while 75% of the firms did allocate computer use charges, only 40% of the firms required forecasting of budgets and/or held the user accountable for charges. Thus, the practice of charging is not practiced as originally thought and may be inappropriate.
- 16 This paper examines five existing taxonomies of end users and classifies them according to ten characteristics including: (1) computing skills; (2) degree of programming required; (3) support; (4) training/education; (5) knowledge of EUC tools; (6) location of users; (7) nature of the applications; (8) level of technical understanding; (9) user attitudes; and (10) degree of user experience. Practitioners can select the most appropriate taxonomy as a definition of end user computing for their companies. Similarly, academicians may find our analysis helpful in defining end user computing for specific research projects.

Description

- 17 The increased use of interactive programs on mainframe and personal computers has made creators aware of the man-machine (or man-program) interface point. This is a result of users becoming more aware that computers and programs can be made friendly. The quality of user-friendliness can be vital to the acceptance of a program, especially for the novice. This paper discusses factors that affect the acceptance of interactive programs. (Paper #31 is an expanded version of this paper.)
- 18 The Management Information and Decision Support System (MIDS) has been supporting senior executives at Lockheed-Georgia for the past eight years. It is rich in the characteristics associated with executive information systems. This paper describes the evolution of MIDS, its characteristics from a user's perspective, its component parts, the benefits provided by MIDS, the success of MIDS, the keys to its success, and future plans for MIDS.
- 19 There are several organization structure alternatives for supporting DSS. This paper explores the advantages and disadvantages of the various alternatives. A particularly attractive alternative, providing support through an end user services group, is discussed in-depth and illustrated through a case study.
- 20 There is abundant literature on the use of financial futures to reduce interest rate risk. While many applications have been developed and evaluated in the literature, little has been done to provide a simple, mathematical model unifying the disparate types of hedges. The purpose of this paper is to provide such a unifying framework. Under idealized conditions, an equation is developed giving a perfect hedge solution for arbitrary choice of (1) planning horizon, (2) existing or planned cash market position, and (3) asset/liability mix. The paper is pedagogic in nature.
- 21 This research addresses two information center considerations: (1) the existence of a stage hypothesis describing the evolution of an IC, and (2) the determination of critical success factors by which IC managers can better manage. Based on 311 responses from IC managers, support is found for the proposed stages, and information is provided about the

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importance of the CSFs. From 26 CSFs recommended by a variety of sources, five composite CSFs are derived by which IC managers can concentrate on the success of the information center.

- 22 This paper is an extension of Working Paper #21. Reported herein is the effect on the composite CSFs of the IC variables age, size, and hardware option supported.
- 23 When management makes the decision to create an information center, it is agreeing to allocate resources. In particular, management is resolving to support the user community with a staff of IC personnel. The question, or problem, is, which staff and how many of them? The focus of this paper is to address the question of how to determine the proper number of IC staff members.
- 24 This paper focuses on the changes to manufacturing theory and data bases required to treat manufacturing capacity as a random variable. The paper presents and discusses an argument that failure to treat manufacturing capacity as a random variable in planning is a leading cause of job tardiness.
- 25 The purpose of this study was to test whether dynamic (moving) computer-generated graphics are more useful than static (still) graphics in problem-solving situations. Results show that individuals using dynamic graphics have higher problem-solving accuracy than individuals using static graphics. The concept of "computerthink" is introduced and discussed.
- 26 The purpose of this research was to identify and test several factors which may contribute to the effectiveness of end-user developed applications. This study: 1) examines the concepts of end-user computing and organizational effectiveness, 2) investigates how large corporations are utilizing specific end-user tools and techniques, and 3) tests the relationships between the independent variables (end-user support, EUC tools, attitudes toward EUC, IS backlog, experience, and EUC policies) and the effectiveness measures of utilization and user satisfaction.

The validation of the conceptual model addresses several areas related to end-user computing. Recommendations are made concerning the factors

which contribute most to the effectiveness of EUC in organizations. We hope the results will be useful to firms dealing with similar end-user computing management issues.

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|----|---|
| 27 | Fifty-Five organizations in which decision support systems (DSS) are used were surveyed to determine how they are supporting DSS activity. The findings provide insights about the extent to which DSS activity is being supported, which organizational units are providing support, the types and frequency of support provided, the organizational units and management levels that receive support and how often it is provided, and the perceived quality of the support. Typically, DSS support is available through between one and four locations in an organization. Personnel working at different levels in their organizations and in different functional areas have distinct patterns of use of DSS support services. |
| 28 | This paper reports on a follow-up survey of 45 information systems managers to determine the changes in skill requirements and projected IS manpower needs that have taken place since 1978. While the original study by Cheney and Lyons (1980) focused only on the nation's largest organizations, the respondents in this survey are employed by organizations of varying size. Data were gathered via structured interviews and compared with the 1978 results by using t-tests. Survey results were used to examine the relative importance of the six skill requirements areas highlighted in the information systems (IS) curriculum recommended by the Association for Computing Machinery (ACM). |
| 29 | One of the time-honored methods of collecting research data is via survey questionnaires. Where a large number of responses is desired, the researcher creates a paper-based questionnaire and distributes it to the particular sample population. Capabilities now exist to place a questionnaire in a computer-based form, providing technology assistance to the respondent and the researcher. This paper discusses the effect of attempting a computer-based survey instrument and the implications of such efforts. |
| 30 | It is often claimed that the support of management is necessary and sufficient to successfully implement the introduction of new technology. However, additional factors are required to successfully initiate change. |

Description

The primary factor associated with the successful implementation of a new technology is a strong advocate, a champion. This paper discusses the role of the champion.

- 31 The increased use of interactive programs on mainframe and personal computers has made creators of programs aware of the man-machine (or user-program) interface. Such awareness is a result of users' becoming more aware that computers and programs can be made friendly. A program that is user-friendly is more likely to be accepted by users, especially novices. This paper discusses factors that affect the acceptance of interactive programs and presents the results of a computer-based survey questionnaire completed by 124 computer program creators and users. Respondents rated the importance of 20 factors and the frequency with which they are used, as well as placing the factors in rank order. Significant differences were found in the ratings of the importance and frequency of use of factors on a global and vocal level by male versus female respondents and by respondents in various positions in their organizations. The factors examined are associated with user learning, adaptability, behavior, and program error control.
- 32 Rapidly changing technology makes the information systems (IS) field a highly dynamic one. IS professionals must possess the requisite skills to be successful in this environment. At an April, 1988 meeting of The University of Georgia - MIS Industry Advisory Board, twenty Board members ranked the skills that new MIS graduates should have if they seek an entry-level position as a programmer, systems analyst, or end user support professional. Separate ranked lists were generated through collaborative work system (CWS) software so that required skills could be compared across entry-level position. The findings provide insights to the changing needs of industry and the implications for academic programs in colleges and universities.
- 33 The information center (IC) concept has been widely accepted since its introduction by IBM in the early 1980s. Research has shown that IC personnel must have special talents. The fact that ICs are well received by the user community is due, in part, to the competent personnel. A questionnaire was sent to more

Description

than 230 companies known to have information centers. Profiles of IC staff positions, descriptions of career respondents' view of current IC positions and future career possibilities are based on the 205 responses received from IC managers and staff personnel. career paths that lead to IC positions, career paths within the IC, and career paths after service in the IC are examined.

34 The Information Center plays a major role in supporting end user computing. As a newly emerged DP strategy, the information center has recently gained a great deal of popularity and attracted the attention of both managers and academicians.

In attempting to predict or evaluate the success of the information center, however, managers and researchers have typically encountered a problem in determining which factors contribute to success, and to what extent each of them influence the success of the information center. The literature in the field has identified up to 26 factors critical to the success of an information center. These critical success factors were subsequently reduced to five composite factors by using factor analysis. While having fewer factors should greatly reduce the prediction and measurement problem, it does not eliminate it entirely. This is because it is often difficult to obtain measures (ratings) of even these five factors. To identify a composite measure of success, it is also necessary to ascertain the relative contribution each of the factors makes in determining the success of the information center. Examining the relationships between the five factors helps to resolve the problems of how many critical factors need to be looked at and how each of these factors should be weighted on a composite index of information center success.

35 As interest in developing expert systems continues to grow, it becomes more important for us to increase our understanding of how to successfully build these systems. A major factor that currently constricts the development of expert systems is the formidable process of eliciting knowledge from human experts: knowledge acquisition. An exploratory study utilizing the Critical Success Factor (CSF) methodology was conducted to determine critical factors in the knowledge acquisition process for expert systems

Description

development. CSFs are the factors that must go right for a process (or project) to be successful.

Thirteen professionals from ten organizations who perform knowledge acquisition activities participated in the study. We utilized a Collaborative Work Support (CWS) system in order for the participants to generate and categorize CSFs. Based upon this factor generation and subsequent discussion, we prepared questionnaires for participants to rank CSFs for four areas: (1) the overall expert systems development process, (2) the knowledge acquisition process, (3) knowledge engineer attributes, and (4) facilitating the knowledge engineer - domain expert relationship. Open-ended questions were also included in order to get additional information about knowledge elicitation techniques. The results of these questionnaires are presented along with additional information from the original factor generation and categorization process, the discussion and follow up interviews.

While it is apparent that there are a number of critical factors that influence the success of each expert system project, there appear to be several factors that are critical to all projects. The importance of several factors underscores the complexity of knowledge acquisition, as well as the overall expert systems development process. For example, the importance of selecting the appropriate domain and application were found to be critical. Strong support of management and the willing participation by experts are also key factors. A strong preference for "soft" skills (e.g., communication skills, rapport, understanding the problem domain) emphasize the complex set of skills essential for individuals in this position.

This is an exploratory study and its findings should be viewed with some caution. However, we do believe that it has "shed some light" on what factors are critical for successful knowledge acquisition and expert systems development.

The advent of microcomputers, end user computing, and generalized access to corporate data has led many to believe that the audit environment is at risk. Some authors indicate that the proliferation and use of microcomputers, especially as intelligent terminals, poses a problem to data integrity. Others believe

Description

that user-developed applications create a significant risk to the total information systems environment, especially to those parts requiring audit. This paper discusses these considerations and contends that neither the addition of microcomputers and end user computing nor generalized data access a new or increased risk to the auditor's domain.

- 37 The importance of effective training in ensuring the success of end-user computing (EUC) has been emphasized by several researchers in Information Systems. A vast amount of evidence from research in related areas such as educational psychology suggest that individual differences, for example, a novice end user's learning style, may affect his/her learning of a new EUC software package. This paper reports the findings of a series of studies that examined the influence of a novice's learning style in learning of typical EUC tools such as spreadsheets and electronic mail. A consistent pattern of findings emerged that indicates that learning style is an important predictor of learning performance, both by itself and in interaction with training methods. The findings suggest that in the design of training, it is essential to match training methods to individual difference variables. Based on these finds, guidelines are recommended for IS professionals involved in EUC training. Further research directions are suggested.

- 38 Inadequate system requirements specifications reflect ineffective communication transactions between system users and developers. Today, effective communication between developers and users is more important than ever as organizations redirect resources to the development of decision/expert and communication support systems and to helping users develop their own systems.

This paper reports on an exploratory study which tested the use of the Precision Model, a generalized communication model that draws upon a set of communication behaviors to facilitate effective communication between users and developers. These behaviors were incorporated into a general format for running design team meetings. The findings indicate that the new meeting format improved the communication between the communication between users and developers and enhanced their ability to develop shared, accurate

Description

and complete system requirements. In addition, the use of this format led to a reduction in the number and length of meetings. It also demonstrated that developers were better able to develop and maintain rapport with users and that team members felt more productive and satisfied when meetings concluded. This research identifies specific behaviors and guidelines that can be used to improve the requirements definition process in any systems development project.

39

It has been reported by managers and professionals that approximately 50% of their time spent in meetings is wasted. New computer technologies are evolving which are aimed at improving the efficiency and effectiveness of "electronic meetings." This article provides first a conceptual description of these "Collaborative Work Support Systems" (CWSS). Three types of approaches to the design and use of CWSS are discussed, and the implications of this technology on groups is described. Second, the detailed description of a case involving a three-day electronic meeting facilitated by the authors is presented. The group included 14 officers and staff of the Data Processing Management Association engaged in their annual planning and budget development. Both quantitative and qualitative assessments of the meetings' efficacy are reported which demonstrate how the use of CWSS can result in a highly productive meeting.

40

Design teams, composed of users and system developers, are often used to develop logical systems designs (LSD) for information systems in organizations. Research suggests that high participation and influence by both users and developers is critical to successful development efforts. However, group processes often detract from the potential effectiveness of team work. A new set of computer technologies is evolving which is aimed at overcoming common problems with group interaction and improving the efficiency and effectiveness of "electronic meetings." This article provides first a conceptual description of these "Collaborative Work Support Systems" (CWSS). Three types of approaches to the design and use of CWSS are discussed, the the potential implications of this technology for design teams is described. Second, a procedural model of the LSD process is developed which illustrates how CWSS and Computer-Aided Software Engineering (CASE) tools can be integratively applied to improve design teams

EUCRC

WP#

Description

productivity. Finally, a number of outstanding design implementation and research issues are discussed regarding the use of CWSS and CASE technologies for LSD by design teams.

MANAGEMENT INFORMATION SYSTEMS RESEARCH CENTER

ANNUAL REPORT
1987 - 88

Curtis L. Carlson School of Management
University of Minnesota

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University of Minnesota**

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1987-88

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UNIVERSITY OF MINNESOTA
TWIN CITIES

*Curtis L. Carlson School of Management
271 19th Avenue South
Minneapolis, Minnesota 55455*

Message From the Dean

Our mission at the Carlson School of Management includes a strong concern for developing knowledge in the field of management. The School's Management Information Systems Research Center (MISRC) takes this development a step further by facilitating research whose results can be applied directly in business situations.

One of six research centers in the School, the MISRC has been a national model for other schools attempting to conduct research that is beneficial to the practitioner. The Center provides seminars given by prominent leaders and innovators in the field, organizes discussion groups among its member companies, and publishes the *MIS Quarterly*, one of the top-rated MIS journals for academics and practitioners. These efforts are made possible by the financial support of the several Twin City "Associate" firms. MIS representatives of these firms also suggest timely topics for MIS faculty and Ph.D. student research, act as subjects in survey research, and provide business projects that are analyzed by MBA student teams.

The Center premiered this kind of liaison with the business community when it began in 1968, and many of the founding companies are still members today. As the Associates, faculty, and staff of MISRC celebrate their twentieth anniversary, the Carlson School congratulates them on 20 years of excellence.



UNIVERSITY OF MINNESOTA
TWIN CITIES

Management Information Systems Research Center
Carlson School of Management
355 Humphrey Center
271 19th Avenue South
Minneapolis, Minnesota 55455-0413
(612) 624-6565

June 1988

This month marks the end of another successful year at the MISRC. Research efforts continued in the areas of interest to Associate firms. Those areas are MIS management, MIS planning, systems development, computer graphics, database, end-user computing, decision support systems, and organizational and behavioral issues of MIS.

Specific accomplishments of particular interest are:

- . Lutheran Brotherhood and Minnesota Mutual joined the Associates program.
- . AT&T joined and Burlington Northern rejoined the Associates program for 1988-89.
- . Research productivity was excellent as evidenced by 21 new or continuing research grants, 41 articles, 12 working papers, and 8 new books completed.
- . The 15 Associate seminars and 7 discussion groups received excellent participation.
- . Executive Development Center programs in MIS continued to receive excellent ratings.
- . MISRC maintained national leadership in working with the Society for Information Management, the *MIS Quarterly*, the International Conference on Information Systems, and the Association for Computing Machinery.
- . MISRC continues the review process for *Data Base*.

On a special note, the MIS area of the Carlson School of Management will be hosting the 1988 International Conference on Information Systems in Minneapolis, November 30-December 3. In conjunction with the Conference, MISRC and the MIS program will be celebrating 20 years of continued success. The financial and advisory support of the Associate firms have made this success possible.

A very special thank you to all the Associates, MIS faculty, Department of Management Sciences, Carlson School of Management, and MISRC staff for their support and cooperation during the past year.

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1987-88

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Annual Report
1987-88

INTRODUCTION

The Management Information Systems Research Center (MISRC) Annual Report provides an overview of MISRC activities. It is the primary means of communicating and documenting the accomplishments of the MISRC and is distributed to MISRC Associates, faculty, universities, and other interested persons or organizations.

As a reference guide to the Annual Report, an index has been included to allow readers to locate specific accomplishments by topics (for example, MIS planning, systems development, end-user computing). Therefore, if you are interested in the most recent work we have done in an area such as systems development, the index would direct you to those programs, articles, working papers, dissertations, *MIS Quarterly* articles, etc., that are relevant to that topic.

HISTORICAL OVERVIEW

The Management Information Systems Research Center was established at the University of Minnesota in the Graduate School of Business Administration in 1968. The original primary objective was to begin a formal graduate level program to educate MIS practitioners and educators. Research addressing the managerial usage of computers in organizations was begun to support and compliment the educational objectives. These endeavors in education and research were started through the financial and personal support of the Minneapolis/St. Paul business community, acknowledged as *Associate firms*.

After successfully launching the MIS educational program, the MISRC shifted its efforts to more strongly support the efforts of its faculty in experimental research into developing user-oriented management information systems and began to build a formal program of seminars and services to promote a stronger relationship with those companies providing support.

Representatives of the Associate firms provide internships and team projects for real work experiences for students in the program, and participate as subjects, advisors, or sources of information for surveys and research projects. The Associates program provides a vehicle for interested companies to work with the University to produce graduates who are equipped with the skills and knowledge to make them valuable MIS business professionals.

The Associates program has been the primary source of financial and advisory support during the MISRC's twenty years of education and research. This close working relationship with the business community has made the MIS program at the University of Minnesota an international leader in the field.

STRATEGIC ISSUES AND ACTIVITIES

A major objective of the MISRC is to focus on strategic issues of interest to the MISRC, Management Sciences faculty, and Associate firms. Each year key people from these three areas define the strategic topics for the coming year. Ongoing strategic research thrusts are in the areas of:

- MIS Management
- MIS Planning
- Systems Development
- Computer Graphics
- Database
- End-User Computing
- Decision Support Systems
- Organizational and Behavioral Issues of MIS

The MISRC activities that support the identified research topics are:

Programs and Workshops -- Presentations on leading issues, drawing from nationally prominent practitioners and scholars.

Research -- Scientific investigation, supported by grants from state, federal, or private agencies, into major MIS issues using case studies, field studies, field experiments, and laboratory research.

Discussion Groups -- Discussions and studies conducted by participants from Associate firms, MIS faculty, and students on pertinent issues. These may result in MISRC working papers. They focus on topics defined by Associates during the annual planning session.

Student Projects/Internships -- Experiential training of students who participate in relevant projects under the supervision of specified individuals in Associate firms.

Working Papers -- Preliminary publication of major research being conducted by MIS faculty and select papers prepared by graduate students and discussion groups.

Information Clearing-House -- Central location for information on specific MIS topics, literature, training programs, faculty, and organizations.

Training Programs -- Programs offered several times a year through the Executive Development Center of the School of Management.

Training Development -- Assistance to Associates in developing their own in-house training programs.

Consulting -- Assistance to organizations in addressing MIS management and technical issues.

ACCOMPLISHMENTS BY ACTIVITIES

This section provides a comprehensive list of accomplishments by each activity. Those reviewed are:

- Seminar Programs
- Research
- Discussion Groups
- Student Project Teams
- Training Programs
- Training Development
- Consulting

SEMINAR PROGRAMS

Objective: To provide 12-14 seminar programs.

Accomplished: Fifteen programs were held.

Specific topics, speakers, and a brief summary of each seminar are listed below. The summary of attendance at all events for 1987-88 is listed in Appendix II.

Calendar of Associates Programs 1987-88

1. September 30 *Fall Kickoff Meeting* James C. Wetherbe
University of Minnesota

Held every Fall, this dinner meeting provides an opportunity for Associates to meet and talk with other Associates, Management Science Faculty, and MISRC staff members. The upcoming year's seminar program, and other areas of research and interaction are previewed.

2. October 21 *MBA Night* James C. Wetherbe
University of Minnesota

Early access to MIS students entering the job market has been and continues to be of high interest to Associate firms. In order to facilitate this, MISRC each year arranges a session for students and Associates to meet and talk in an informal setting.

3. November 6 *The Market Driven Company:
Implications for an MIS Department* Ken Roering
University of Minnesota

This seminar discussed the market-driven company, which is much more than a company with a well-regarded marketing strategy and/or marketing and sales department. It is a radically different view, on the part of the company and all its employees, of how to drive and orient the whole company towards producing products and services for targeted consumer groups through selected distribution channels.

4. November 12 *Information Technology Master Plan:
Singapore as a New World Center* Gordon B. Davis
University of Minnesota

This presentation showed how the Republic of Singapore, an island with a population equivalent to the Twin Cities, has developed an information technology (IT) plan for aiding business and government organizations to effectively use computers and other information technology. The plan includes education, training, consulting, experimental programs, and various incentives. The result is expected to make Singapore a major center for IT in Southeast Asia and provides insight to Minnesota companies doing IT planning.

5. November 24 *The Introduction of Personal
Computers in Organizations: What
Have We Learned From Round One?*

James C. Brancheau
University of Minnesota

This seminar reported on the results of an MISRC/Arthur Andersen study on the diffusion of spreadsheet software in finance and accounting departments. The study, which involved interviews and surveys of over 500 professionals in 24 business units from 18 companies, found important differences between earlier and later adopters of technology with respect to their age, education, media exposure, and communication behavior. It also found that most IS groups acted too late and offered too little support to have a measurable effect on the diffusion process. The implications of the study and some guidelines for managing the introduction of personal computing technology in organizations were discussed.

6. January 13 *Telecommunications: Strategic
Planning...Target Network
Architecture...in a Multi-Vendor
Environment*

John J. Bjelland
The Pillsbury Company

Pillsbury's Worldwide Standard Planning Methodology for Telecommunication has four distinct phases: (1) MIS assessment and business direction, (2) target architecture, (3) delivery strategy, and (4) master plan. This seminar described how planning is done from two perspectives -- within the premise by site type (e.g., typical factory, data center, distribution center, headquarters building, store, etc.) and premise to premise (wide area communications). The premise planning includes voice, data, image, video and overall premise wiring. Wide area telecommunication planning includes network design, media, carriers, and protocol support.

7. January 22 *Models for Software Development
Management*

Chris F. Kemerer
MIT

Current software development typically is very costly and produces a product that is not very reliable. This worst-of-all-possible worlds situation provides a stubborn bottleneck to the effective implementation of many innovative uses of information technology. Numerous solutions, in the forms of methodologies and tools, have been proposed. This presentation focused on two completed pieces of research in this area and described some ongoing efforts. The first completed study tested some current models for software cost estimation. The second completed study developed a model for measuring the productivity of software maintenance projects.

8. February 4 *Computer-Mediated Meetings:
Using Computing to Support Face-
to-Face and Dispersed Conferences*

Gerry DeSanctis
M. Scott Poole
University of Minnesota

The use of computer technology to support management decision making is moving from the desktop to the meeting room. A variety of prototype and commercial technologies are available to organizations for the support of face-to-face and dispersed meetings. This presentation discussed electronic board room technology, decision networking, and other computer-based technologies intended to support the group activities of managers.

9. February 19 *Creating Effective Information
Environments for the Home*

Nicholas P. Vitalari
University of California, Irvine

Increasing numbers of managers and professionals are finding that information environments in the home (i.e., coordinated architectures for personal computing, electronic mail, online corporate databases, and commercial information services) are productive adjuncts to their

office environments. This presentation probed the use of information environments in the home. Results from a national longitudinal study of computing use in the home indicate that such alternative work arrangements can release organization resources, assist employees in dealing with critical time demands, and improve the bottom line. Organizations that fail to understand the transforming role of information environments are overlooking an important strategic option for employee effectiveness.

10. March 2 *Systems Development With
Prototyping, Data Modeling,
Computer-Aided Software Engineering,
and All That Jazz* James C. Wetherbe
University of Minnesota

Recent advancements in both the technology and techniques of information systems development are resulting in dramatic changes in the way information systems are developed. Key technologies and techniques include CASE, 4 GLs, relational databases, information architectures, prototyping, data modeling, and structured techniques. Many organizations are fragmented in the manner in which they implement these tools, often losing their full potential benefit. Implemented properly, these tools will result in superior systems development in less time. This seminar investigated these new technologies and techniques and showed how to integrate them into the systems development.

11. March 29 *Educating Top Management on IS* Carl Wilson
The Pillsbury Company
Gary Hanson
The St. Paul Companies
Dave Johnson
National Car Rental System

The members of this panel discussed several important questions that can encourage the participation of top management in IS issues. They include: (1) What is it that senior management wants to know? (2) Are senior managers threatened by IS? (3) Educating senior management is a two-way street: top management has a responsibility. How can this be communicated to them? IS has a role to play. "Outward-in" education works. How can we learn to frame our concerns in top management terms? (4) Strategic versus cost decisions. Can we get upper management familiar enough with IS so they develop that "intuitive" gut-feel reaction that makes the bottom-line figures secondary?

12. April 14 *Planning for Information Systems:
A View From the Trenches at AT&T* Jeffrey A. Hoffer
Indiana University
John J. Carroll, AT&T
Stephen J. Michalee, AT&T

An important step in the management of a resource is planning. For a large, dynamic and costly resource like data systems, strategic planning can be used to establish a blueprint and priorities for its prudent evolutionary development. This seminar reviewed actual experiences with a process that is being used for strategic system and data planning at AT&T and other organizations.

13. April 29 *Managing the Data Resource:
A Contingency Perspective* Dale L. Goodhue
University of Minnesota

Are some firms successfully using data management approaches to address key business problems or opportunities? To find out, three researchers at MIT's Center for Information Systems Research conducted case studies of 31 data management efforts in 20 diverse firms. Their findings are controversial because they suggest that the most commonly recommended

approaches to data management may not be the most effective. They found that successful firms adopted a variety of approaches that differed in (1) business objective, (2) organizational scope, (3) planning method, and (4) the deliverable produced. This seminar presented these findings and their implications, and suggested recommendations for data management actions in large corporations.

- | | | |
|------------|---|---|
| 14. May 13 | <i>Telecommunications as a Strategic Resource</i> | Jagdish N. Sheth
University of Southern California |
|------------|---|---|

A number of factors are shifting the role of telecommunications from the utility function to the strategic function in the organization: (1) competitive advantages created by telecommunications technologies especially for just-in-time operations; (2) mergers and acquisitions on a global basis that create a need for real time networks; (3) technological evolutions and some revolutions that are making telecommunications affordable; (4) deregulation of the industry has encouraged more choices for the customer. This session discussed each factor and suggested ways in which organizations can utilize telecommunications.

- | | | |
|-------------|-------------------------|--|
| 15. June 16 | <i>Year-End Meeting</i> | James C. Wetherbe
University of Minnesota |
|-------------|-------------------------|--|

The past year's activities were discussed, and strategic direction for next year and future years was set.

RESEARCH

Objective: To generate research efforts in all strategic areas (i.e., MIS management, MIS planning, systems development, computer graphics, database, end-user computing, DSS, organizational and behavioral issues of MIS). Other research topics were also encouraged.

Accomplished: Twenty-one research grants (those continuing from last year are marked by an *), 12 working papers, 42 articles, and 8 books were generated by MIS and related faculty and/or MIS Ph.D. students. Six MIS Ph.D. students completed their dissertations this year; four others have successfully defended their dissertation proposals.

Research Grants

COMPLETED PROJECTS

1. *The Minnesota Managerial Graphics Project*, G. DeSanctis, G. Dickson, J. Lehman, and D. McBride. Funding: 3M, Decision Resources, Inc., Integrated Software Systems Corp.

The Minnesota Managerial Graphics Project was initiated in 1983 to study the use of computer graphics for business applications. The project aimed to identify trends related to the use of graphics technology, to examine the effectiveness of graphical tools for decision making and related managerial activities, and to develop a theoretical foundation for further research on graphical methods of information display. A series of studies was conducted using survey, experimental, and field study methodologies.

2. *Trends in MIS Organizational Structures*, C. Roger, D. Vogel, and J. Wetherbe. Funding: MIS Research Center.

This was stage II of a preliminary study conducted with Twin Cities Associate firms in 1984-85. The project was a national survey of MIS department structures. The objective of this study was to take a snapshot of current MIS organizational structures over a broad set of industries and companies, with two purposes in mind: (1) to identify emerging structures and their location in the MIS department; and (2) to provide a basis for tracking MIS organizational structures in future studies.

3. *A Survey of DBMS and Related Tools*, G. Everest. Funding: MIS Research Center.

This study sought to discover the factors which inhibit or enhance the penetration of better tools into the process of systems development. A survey determined the extent of use of the tools. Subsequent structured interviews attempted to discover the specific ways in which selected organizations overcame the resistance to using the better DBMS tools.

4. *Information Centers: An Assessment of Problems and Successes From Two Perspectives*, R. Leitheiser and J. Wetherbe. Funding: MIS Research Center.

A 1984 survey investigated end-user computing and information centers. This study was a follow-up to that survey and was designed to clarify some of the issues relating to information center success. The perspectives of both the IS executive and the IC manager were combined to assess the levels of importance of various critical success factors.

5. *The Representation Research Program*, J. Naumann, S. Juhn, C. Wells, T. Larsen, M. Alanis, and R. Ye. Funding: Graduate School, IBM Project, and Carlson School of Management.

This program began in 1984. Research was conducted in the general area of information requirements determination for systems analysis, software engineering, and knowledge engineering. Studies under this program were intended to discover more about the way systems analysts, software developers, and knowledge engineers discover user needs and prepare system specifications. The concerns are long-range; rather than comparing existing tools and techniques, a theoretical explanation for functional and dysfunctional analyst behavior was developed. The goal was to describe, from a strong empirical basis, the knowledge, actions, and supporting tools that assure effective discovery of needs and produce complete, correct, verifiable system specifications. To date, results have appeared in the 1985 *Proceedings of the Decision Sciences Institute* and the 1985 *Proceedings of the International Conference on Information Systems*.

6. *Organizational Response to Data Privacy and Fair Information Practices*, G. Everest and K. Winter. Funding: MIS Research Center and Carlson School of Management Honors Undergraduate Program.

This research involved a survey of 50 local organizations concerning the extent of their compliance with the laws and principles of data privacy and fair information practices. The study looked at policies related to personal data on employees and customers/clients and assessed the progress made toward responding to the provisions and principles embodied in the laws passed ten years ago.

7. *Assessment and Evaluation of the MIS Function*, G. Dickson, C. Wells, and R. Wilkes. Funding: MIS Research Center.

This project was designed to determine how to assess the effectiveness of the MIS function in an organization. Both field and experimental research was employed to isolate key factors to serve as a surrogate for the desired ROI from the MIS organization.

8. *The Evolution of the Information Center: A Longitudinal View*, J. Brancheau. Funding: MIS Research Center.

The growth and evolution of the information center (IC) were analyzed over a multiple-year period. A variety of managerial and technical indicators were tracked. The objectives of the study were to provide descriptive information on the growth of the IC and to improve understanding of organizational responses to technological innovation.

PROJECTS IN PROGRESS

9. *Management of Information Systems*, Carlson School of Management, T. Hoffmann, Director; G. Dickson, G. Davis, and J. Wetherbe, major project responsibilities. Funding: IBM.*

The School of Management was among 13 schools awarded a \$2 million grant to support graduate curriculum development and research in the management of information systems. Half of the grant is in the form of IBM equipment; the remainder is for research and educational development in graduate programs in the School. The research component emphasizes the management of information systems. The educational part will have significant benefits for both the general MBA program and the MBA with MIS concentration.

10. *The Knowledge Interview Subject System Project*, D. Naumann, C. Beath, R. Ye, and M. Alanis. Funding: Project WOKSAPE, IBM Project.*

The KISS project is a developmental effort aimed at designing, prototyping, and implementing a system to support teaching and research in systems analysis. The project is using artificial intelligence tools (GC LISP) on a microcomputer (IBM PC/AT). KISS is intended to respond to a systems analyst's questions in the way that a user might. That is, KISS interprets English language questions, searches its knowledge base, and responds in English. The KISS knowledge base will contain facts users would be expected to know about an application domain, for example, a particular inventory control system. Later versions of KISS are expected to modify their responses from the purely factual by behaving like different individuals in different organizational roles, so the questioning analyst sees different responses to the same question depending upon the interview subject. The working version of KISS is to be completed in Fall 1988.

11. *The Use of Information Technology for Competitive Advantage in New Business Venture: A Contingency Approach*, R. Cardozo and V. Sambamurthy.*

New business ventures face problems of survival and growth. This project investigates conditions under which information technologies might be utilized for creating successful business strategies.

12. *Group Decision Support Systems*, G. DeSanctis, M. Poole, G. Dickson, R. Watson, I. Zigurs, and V. Sambamurthy. Funding: NCR Corporation, Graduate School, Humphrey Institute Conflict Management Project, and IBM Project.*

Group decision support systems (GDSS) combine computer, communication, and decision support technologies to facilitate managerial meetings. GDSSs are intended to be useful to committees, review panels, executive board meetings, task forces, and groups of managers who work together on either a regular or one-time basis. The ultimate objective of this area of study is to identify computer-based interventions which will improve the manner in which groups of people work together in meetings. This project is devoted to the study of GDSS hardware and software design and its impacts in organizational settings. A software system has been developed and a *decision room* set up. Face-to-face meetings are being conducted in which the effectiveness of the GDSS is being assessed.

13. *Group Decision Making and Group Decision Support Systems*, G. DeSanctis and M. Poole. Funding: National Science Foundation.

The project is undertaking a comprehensive investigation of the effects of computer-mediated meetings (group decision support systems) on group decision activities. A three-year program of interlocking laboratory and field studies will: compare groups supported with computer technology with non-supported groups; compare configurations of system design for computer-mediated meetings; and consider the effects of variations in task, conflict level, and member characteristics on GDSS success.

14. *Data Resource Management Roles and Responsibilities: Exploratory Studies*, D. Goodhue and M. Wybo. Funding: IBM, University of Minnesota.

This project is a series of exploratory interviews with 13 local data resource management professionals. Emphasis is on roles they play to implement the DRM concept in their firms. The project goal is to formulate a set of hypotheses for future empirical testing.

15. *In-Context Assessment of Information Systems*, G. Davis. Funding: IBM.
16. *The Planning and Development of a Model Academic Integrated Information Center*, C. Beath, G. D'Elia, D. Straub. Funding: Council of Library Resources.
17. *Information Technology, Resource, and Services*, D. Straub.
18. *Policy and Legal Issues*, D. Straub.
19. *Executive and Knowledge Worker Productivity*, J. Wetherbe and P. Carlson. Funding: MISRC Associates*
20. *Systems Analysis and Design*, J. Wetherbe. Funding: Index Group.
21. *MIS Planning*, J. Wetherbe. Funding: Index Group.

MISRC Working Paper Series

The MISRC Working Paper Series is a primary communications medium with business, government, and educational institutions. The papers in this series are preliminary publications of major research conducted by MIS faculty and select papers prepared by graduate students and discussion groups. Twelve papers were produced in 1987-88 academic

year, identified as 88 series papers. The topics of these papers are listed below. Since the beginning of this series in 1969, 223 papers have been produced. (A complete listing of all papers is available upon request.)

1. WP 88-01 Positioning Computer Security in the Organization (D. Straub)
2. WP 88-02 Group Decision Making and Group Decision Support Systems: A 3-Year Plan for the GDSS Research Project (M. Poole and G. DeSanctis)
3. WP 88-03 GDSS Technology in Practice: A Study (D. Straub and R. Beauclair)
4. WP 88-04 Interaction Analysis in GDSS Research: Description of an Experience and Some Recommendations (I. Zigurs)
5. WP 88-05 Business Graphics Trends: Two Years Later (J. Lehman and V. Sambamurthy)
6. WP 88-06 A Conceptual Framework for Studying System Innovations (D. Straub)
7. WP 88-07 A Study of Influence in Computer-Mediated Decision Making (I. Zigurs, M. Poole, and G. DeSanctis)
8. WP 88-08 End-User Computing and Knowledge Work: Managing the Introduction of New Information Technology (J. Brancheau and J. Wetherbe)
9. WP 88-09 Testing and Extending Innovation Diffusion Theory in the Context of End-User Computing (J. Brancheau and J. Wetherbe)
10. WP 88-10 Computer Fraud Against Organizations (D. Straub and M. Wybo)
11. WP 88-11 An Investigation into the Use and Usefulness of Security Software in Detecting Computer Abuse (W. Nance and D. Straub)
12. WP 88-12 Mechanisms for Facilitating Managerial Interactions in Information Technology Planning: Directions for Research (V. Sambamurthy and G. DeSanctis)

Articles by MIS and Associated Faculty

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2. Beath, C. M. "Managing the User Relationship in Information Systems Development Projects: A Transaction Governance Approach," *Proceedings of the Eighth International Conference on Information Systems*, Pittsburgh, PA, December 1987, pp. 415-427.
3. Beath, C. M. and B. Ives. "The Information Technology Champion: Aiding and Abetting, Care and Feeding," *Proceedings of the Twenty First Annual Hawaii International Conference on System Sciences* (IV), Kailua-Kona, Hawaii, January 5-8, 1988, pp. 115-123.
4. Beath, C. M. "User Roles and Responsibilities," *Journal of Information Systems Management* (forthcoming).

5. Beath, C. M. "The Information Technology Champion: Some Preliminary Findings," *Proceedings of the Colloquium on Strategy, Technology and Linguistics*, Quebec City, Canada, September 22-23, 1988 (forthcoming).
6. Davis, G. B. "Evaluation of Computer-Aided Software Engineering Packages," *Information Technology* (Journal of the Singapore Computer Society) (1:4), December 1987, pp. 51-55.
7. Davis, G. B. "Information Systems as an Academic Discipline," in *Intellectual Foundations for Information Professionals*, H. K. Achleitner (ed.), Social Science Monographs, Boulder (distributed by Columbia University Press, New York), 1987, pp. 115-141.
8. Davis, G. B. and M. C. Munro. "The Problem of Information Requirements for Computer Applications," *Accounting Horizons* (1:4), December 1987, pp. 105-109.
9. Davis, G. B. and J. R. Hamann. "In-Context Information Systems Assessment: A Proposal and an Evaluation," in *Information Systems Assessment: Issues and Challenges*, N. Bjorn-Andersen and G. B. Davis (eds.), North-Holland, Amsterdam, 1988, pp. 283-296.
10. Davis, G. B. "To Buy, Build, or Customize," *Accounting Horizons* (2:1), March 1988, pp. 101-103.
11. Davis, G. B. "Productivity Gains from Computer-Aided Software Engineering?" *Accounting Horizons* (2:2), June 1988.
12. DeSanctis, G. and R. B. Gallupe. "A Foundation for the Study of Group Decision Support Systems," *Management Science* (33:5), 1987, pp. 589-609.
13. DeSanctis, G., R. B. Gallupe and G. W. Dickson. "Computer-Based Support for Group Problem Finding: An Experimental Investigation," *MIS Quarterly* (12:2), June 1988.
14. DeSanctis, G., R. T. Watson and M. S. Poole. "Using GDSS to Facilitate Group Consensus: Some Intended and Unintended Consequences," *MIS Quarterly* (12:3), September 1988 (forthcoming).
15. DeSanctis, G., V. Sambamurthy and R. T. Watson. "Computer-Supported Meetings: Building a Research Environment," *Large Scale Systems*, forthcoming.
16. DeSanctis, G. and S. L. Jarvenpaa. "Standard Scaling in Decision Graphs: An Empirical Investigation," *IEEE Transactions on Systems, Man, & Cybernetics* (18:5), 1988 (forthcoming).
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18. DeSanctis, G., V. Sambamurthy and R. T. Watson. "A Software Environment for GDSS Research," *1988 Transactions on Decision Support Systems*, June 1988.
19. DeSanctis, G., M. S. Poole, and M. Holmes. "Conflict Management and Group Decision Support Systems," *Proceedings of the Second Conference on Computer-Supported Cooperative Work*, Portland, OR, September 1988 (forthcoming).

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23. March S. T. and Y. G. Kim. "Information Resource Management: A Metadata Perspective," *Journal of Management Information Systems*, Winter 1988 (forthcoming).
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29. Straub, D. W. and R. A. Beauclair. "Current and Future Usage of GDSS Technology: Report on a Recent Empirical Study," *Journal of Management Information Systems*, Summer 1988 (forthcoming).
30. Straub, D. W. "Organizational Structuring of the Computer Security Function," *Computers & Security*, Summer 1988 (forthcoming).
31. Straub, D. W. and W. D. Nance. "Uncovering and Disciplining Computer Abuse: Managerial Responses and Options," *Information Age*, Summer 1988 (forthcoming).
32. Wetherbe, J. C., J. C. Brancheau and R. L. Leitheiser. "Allocating Responsibility for End-User Computing Support: Who's Responsible in the 'Shared' Environment," *Systems Development Management*, October 1987.
33. Wetherbe, J. C. "Rational Framework for Centralizing or Decentralizing Information System Management Functions," *Information Technology* (1:3), May 1987. Reprinted in *I/S Analyzer* (25:11), November 1987.
34. Wetherbe, J. C. and R. L. Leitheiser. "Avoiding Monarchy and Anarchy in End-User Computing," *Proceedings for the Eleventh Arthur Young Professors' Roundtable*, November 14, 1987.

35. Wetherbe, J. C., J. C. Brancheau and R. L. Leitheiser. "The Shared Environment: Determining Responsibility for End-User Computing Support," *Data Processing Management*, February 1988.
36. Wetherbe, J. C. and J. C. Brancheau. "Higher and Lower Rated Information Centers: Exploring the Differences," *Journal of Information Management* (9:1), Spring 1988.
37. Wetherbe, J. C. "How to Minimize Resistance to Change when Promoting Competitive Advantage Systems," *Chief Information Officer Journal*, Premier issue, Spring 1988.
38. Wetherbe, J. C. and J. A. Lehman. "Fourth Generation Languages: Users, Applications, Problems, and Satisfaction," *Journal of Information Systems Management* (6:2), Spring 1988.
39. Wetherbe, J. C. "Feedback: The Key to Making I.S. Pay," *Leaders* (11:2), April, May, June 1988.
40. Wetherbe, J. C. "Monarchy Versus Anarchy in End-User Computing--Ensuring Corporate Strategy by Managing Increasing Dispersion of I.S. Competences," *Proceedings of the Diebold Research Program--Europe*, Zurich, Switzerland, May 9-11, 1988.
41. Wetherbe, J. C. "Cultivating Change--Making It Happen," *Proceedings of the 1988 Conference of the Society for Information Management*, Anugraha, Egham, Surrey, U. K., May 18-20, 1988.

Books Published by MIS Faculty: 1967-88

Note: The following is a complete list of books published by the MIS and related faculty since 1967. An asterisk (*) denotes those published during 1987-88.

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Davis, G. B., M. Olson, J. Ajenstat, and J. L. Peaucelle. *Systèmes d'Information pour le Management--Volume 1: Les Bases; Volume 2 Les Approfondissements*, Editions G. Vermette Inc., 1986; Economica, 1986.

- *1. Davis, G. B. and M. Olson. *Sistemas de Informacion Gerencial*, Editorial McGraw-Hill Latino Americana, S. A., Bogota, Columbia, 1987.
- *2. Davis, G. B. and M. Olson. *Management Informatiesystemen*, Academic Service, Schoonhoven, The Netherlands, 1987.

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- *6. Wetherbe, J. C. and T. Dock. *Computer Information Systems for Business*, West Publishing, St. Paul, MN, 1988.
- *7. Wetherbe, J. C. *Systems Analysis and Design*, Third Edition, West Publishing, St. Paul, MN, 1988.
- *8. Wetherbe, J. C. *Cases in Systems Analysis and Design Specification*, West Publishing, St. Paul, MN, 1988.

MIS Ph.D. Dissertation Research

Six Ph.D.s in MIS were awarded in 1987-88:

- 1. *The Diffusion of Information Technology: Testing and Extending Innovation Diffusion Theory in the Context of End-User Computing*, James C. Brancheau.
- 2. *Problem Solving and Knowledge Characteristics in Information Systems Analysis*, Gernot Langle.
- 3. *An Examination of the Effects of Alternative Scheme Descriptions on the Understanding of Database Contents and the Use of a Query Language*, Robert L. Leitheiser.
- 4. *An Exploration of Team Information Processing in a Dynamic Group Choice Task Involving Uncertainty*, D. J. McBride.
- 5. *The Effect of Semantic Organization of Menu Systems on Console Operator Performance*, F. Jay Van Wetering.
- 6. *The Effect of Computer-Based Support on Influence Attempts and Patterns in Small Group Decision-Making*, Ilze Zigurs.

The following MIS dissertations are in process:

- 7. *Contextual Relevance in Analogical Reasoning: A Study of Legal Expertise*, Keith Bellairs.
- 8. *Information Acquisition Behavior of Expert and Novice Systems Analysis During an Information Requirements Determination Task: An Experimental Analysis*, Sung Juhn.
- 9. *Managers' Personal Use of Computers: Middle Managers' End-User Computing Utilization and Support Requirements by Level of Innovativeness*, Tor J. Larsen.
- 10. *A Comparison of Two Levels of Computer-Based Support for Conflict Resolutions and Communications Management in Equivocality Reductions During Shareholder Analysis*, V. Sambamurthy.

DISCUSSION GROUPS

Objective: Organize 7-10 discussion groups focusing on most frequently requested topics as defined by Associate firms and MIS faculty.

Accomplished: Seven groups were organized.

Each year the Associates identify several specific topics that are of common concern to their organizations. Approximately ten of the most frequently listed are chosen and formed as discussion groups. The purpose of these groups is to bring together 6-10 people who have a common interest in a topic to share experiences and to cooperatively explore and evaluate options in one or two meetings. If further exploration and evaluation is needed, additional meetings are scheduled. Occasionally the group will generate a position paper to be published as an MISRC working paper.

This year seven groups were formed, with an average membership of nine persons per group. The participants included 18 Associate firms (see attendance summary in Appendix II for your company's total attendance), 12 graduate students, and 6 MIS faculty. A brief description of each topic is listed below.

1. **Educating Senior Management in IS Issues:** An effective information systems department often depends on the active support of senior management. This support is sometimes lacking because senior managers may understand the business and their specific functional area, but have no appreciation for the organizational and technological challenges facing the information systems executive. The focus of this group was on identifying the issues senior managers must understand to gain this appreciation, and on how to educate them in these issues.
2. **Selling Competitive IS Applications to Management:** Although attendance was minimal, discussion among the participants was generally good. Topics covered included quantifying potential benefits, aligning the IS function with the business, and getting management to listen to IS's ideas. The discussion group met approximately six times before ending in early April.
3. **Developing an Information Architecture and Developing Information Systems with CASE Tools:** Because of similar interests and focus, these two groups were merged into one. During the year, the group compiled a list of the most popular CASE tools available. The members found that it was difficult to evaluate non-homogeneous tools, so part of the group's energy was invested in the development of a questionnaire to facilitate the evaluation of CASE tools. There was further study of the most promising tools for development of information systems and information architectures. The group generated a short list of tools and prepared an information package with the descriptions and user's opinions of selected tools. The group continues to meet and plans to invite presentations from the current users and from the vendors of the best tools for a CASE fair late next Fall or early next year.
4. **Marketing New Information Technology to the Organization:** Introducing technological innovations is not always an easy task. Even if the technology is flawless, the organizational unit in charge of the introduction has to deal with the operational, cultural and political changes brought by the innovation. Perhaps the most common example of a technology that will affect the organizational culture, and eventually society as a whole, is voice mail systems. The group discussed the experiences of several organizations in the introduction of voice mail systems. The group also focussed on the training programs and the efforts that some organizations are making to create a culture for innovation and change in their upper and middle management.

5. **Integrating New Technologies with the Organization's PC Strategy:** The second generation of personal computers has emerged. The long-range implications of these and other new technologies upon the managed use of personal computers is uncertain. This discussion group focused on identifying the new technologies which are relevant to the use of personal computers in organizations. The objective of this group was a contingency model for integrating new technologies.
6. **Using Expert Systems in Organizations:** Examples of expert systems are increasingly being found in medicine, geology, and aerospace industries. Unlike human experts, who can only be in one place at one time, expert systems offer the promise of working simultaneously at many locations. Who will design these systems? What are the special problems involved? How feasible are they for business applications? Can they be effectively developed around today's technological capability or must they wait for future developments in computers that process data in different ways? This group had several speakers to address these questions, and still continues to meet.
7. **Identifying Management Issues in Telecommunications:** The deregulation of the communications industry has made telecommunications a major management concern. With deregulation has come a proliferation in alternative technologies and vendors, as well as the advent of technological advances which are changing the underlying basis of communications. This discussion group hoped to identify and explore the major management issues facing organizations with respect to telecommunications, however because of lack of attendees, it only met once.

STUDENT PROJECT TEAMS

Objective: Respond to requests from Associates for student teams.

Accomplished: All requests for teams were met.

Student project teams evolve out of the School of Management course entitled MBA 8065. The course is required for all students in the MBA program and involves a group project experience in which teams of four students work on a real management problem in a Twin City organization. The project experience is designed to allow the students to put theory into practice. The MISRC helps promote this course to its Associate firms.

Nine Associate firms requested and received twelve student teams, of which eight were MIS-related. A brief description of each MIS project is listed below.

1. Timing of product introduction is critical to this company's success. The challenge for this project team was to provide tools to the company's product developers to enable them to manage development projects more efficiently and to shorten the development timetable. Minimum results included a credible estimate of the return that would be provided by a formal project management system. Better results included overall guidelines for what the system would look like. Best results included a recommendation of a software package or design parameters for writing one.
2. The information center is a group set up within this company's corporate MIS area to provide consulting, support and education on end-user computing tools. The problem the IC group faced was whether they provided the right tools and the right support to the right levels. The project team interviewed a number of IC's clients (approx. 350) and determined overall positive and/or negative trends in productivity as related to workstations.

3. The challenge faced by one MBA team was to assist the company's IS department in determining the appropriate strategy and actions needed to successfully place workers displaced by automation in other jobs within the company and to assist the IS department in defining the costs and timetable required for re-aligning operations work-stations and personnel.
4. Because of an inundation of paper, this team was asked to determine what changes could be made in the way the MIS department operates that would reduce the unnecessary flow of paper as well as streamline the flow and storage of important information. Results were to be achieved by: (1) quantifying the amount of important versus unimportant mail received by a cross section of people in the department, and surveying those people for frustrations and inefficiencies associated with paper flow and documenting their ideas for improving the flow of information; and (2) designing a "Reduce the Paper" campaign.
5. The primary hindrance in reaching the company's goal of error free processing of each client's request was the inability to receive clear and concise instructions from the client and/or financial planner. Forms needed to be simplified, consolidated and standardized to assist in accurate and timely processing. To this end, the project team: (1) analyzed the most frequent transactions requiring a form, (2) documented the legal requirements for completion of the transaction, (3) recommended a long range plan for simplification, consolidation and standardization of forms where practical, and (4) estimated dollar savings resulting from improved forms (communications) from the financial planners.
6. For the past 2 years, the company has been rebuilding its computer applications and has installed Cullinet IDMS/R data dictionary, DBMS, and associated products for basic business transaction processing. In addition, new applications are under development for Marketing and Sales support. The project team assessed the need for additional DBMS by addressing these questions: Is it worth it to obtain a fully relational DBMS system to use as an additional tool for development and end-user reporting and modeling? Is another DBMS justified for sales and marketing applications? If a relational DBMS is purchased should it also have the capability to replace IDMS, thus reducing the number of software environments to support?
7. Over the last two years, the company's MIS area has devoted a large portion of its effort to developing new systems designed to support the strategic direction of the U.S. as it relates to their industry, in particular what the competition is doing in the area of computer integrated manufacturing (CIM). The project team conducted an assessment of the competition and CIM leaders in other industries. Their findings included a definition of CIM, a description of the type and extent of "CIM-type" automation in the U.S. industry (specifically what the competition is doing with CIM), and a description of the impact and/or benefits achieved from CIM.
8. This project team ascertained the spatial needs (amount, kind, and structure) that are necessary to adequately house: central stores, surplus, and displays of saleables. It determined what this warehouse/store should look like, what kind of space would be needed for the present and future, whether it should be leased, purchased, or built, and the kind of technology that should be available in this space.

TRAINING PROGRAMS

- Objective:** Provide training programs for each of the major strategic MISRC topics of MIS management and systems development, a program for MIS executives, and an overview of MIS in the General Management seminars. Respond to requests from Associate firms for training development in-house, and on a consulting basis.
- Accomplished:** Two programs that included MIS programs were provided and run through the Executive Development Center as national programs and were co-sponsored by MISRC. EDC also co-sponsored with MISRC two in-house MIS programs for an Associate company. Additionally, requests from Associate firms were received and responded to for in-house training development and consulting. Attendance figures for Associate firms can be found in Appendix II.

The EDC co-sponsored programs are:

1. Minnesota Management Academy -- three sessions (James Wetherbe, MIS and Communication skills)
2. Minnesota Executive Program (James Wetherbe, MIS)
3. Systems Analysis and Design (James Wetherbe, MIS)

OTHER MISRC ACCOMPLISHMENTS

This section reviews other significant efforts associated with the MISRC. Included are a discussion of: MIS MBA graduates and the *MIS Quarterly*.

MIS MBA Graduate Program and Placement

The master of business administration (MBA) program at the Carlson School of Management has been in effect since 1979. This program is a full two years (six quarters) for students having a non-business background or four quarters for students with an undergraduate business degree. The first year of the program is a highly integrated, computer-oriented introduction to the basic areas of business. The second year is for concentration in a specialized area of which MIS is one. The program is offered to both day and evening students.

During the 1987-88 program year, 30 MBA degrees were granted in the field of Management Information Systems and two in the related field of Management Support Services. To date, 14 students have been placed. Of these, 3 students have been hired by Associate companies.

MIS Quarterly

The *MIS Quarterly* is a joint publication of the Society for Information Management and the Management Information Systems Research Center (MISRC) at the University of Minnesota. It is ranked by both practitioners and academics as one of the top three journals in importance for communicating information in the area of MIS. The objective of the *Quarterly* is to bring the ideas and efforts of those doing research in the field to the

practitioner applying those concepts in the management of information in the organization. The journal strives for a balance between meeting the needs of its practitioner audience -- primarily middle and upper management -- and the needs of the academic community for a journal with a strong methodological base.

The *MIS Quarterly* has a subscription reaching approximately 3,600 worldwide. It is distributed to all members of SIM, MISRC Associate firms, University of Minnesota MIS faculty, and general subscribers. The main representative for each Associate firm receives a copy for the company's corporate library. Additional copies are available to employees of Associate firms in the Twin Cities for a reduced price of \$25.00/year.

Four issues of the *Quarterly* were produced in this academic year under the editorship of F. Warren McFarlan, Harvard University. A complete listing of articles and authors is provided in Appendix III.

New in 1987 was the establishment of the position of Senior Associate Editor of Theory and Research. This position is currently filled by Izak Benbasat of the University of British Columbia. Dr. Benbasat is responsible for overseeing the strength of theoretical research.

APPENDICES

APPENDIX I

MIS and Associated Faculty

Faculty may be contacted at the following address:

Department of Management Sciences
University of Minnesota
271 19th Avenue South
Minneapolis, MN 55455

CYNTHIA M. BEATH, Assistant Professor--625-1055

B.A., Duke University, 1966
M.B.A., University of California, Los Angeles, 1975
Ph.D., University of California, Los Angeles, 1986

Primary Research Interests:

The demand for and supplying of information technology in the business environment -- in particular, the uses of information technology for strategic advantage, and the management issues in developing and maintaining information systems.

Current Research:

1. Strategic uses of computing;
2. IS project management;
3. Managing software maintenance.

GORDON B. DAVIS, Professor--624-2523

B.A., Idaho State University, 1955
M.B.A., Stanford University, 1957
Ph.D., Stanford University, 1959

Primary Research Interests:

Conceptual foundations and structure of management information systems; analysis and design of information systems; auditing and control of EDP; management of knowledge work.

Current Research:

4. In-context assessment of information systems function;
5. Management of knowledge work;
6. Information systems requirements determination;
7. Strategic planning for information systems.

GERARDINE L. DeSANCTIS, Associate Professor--624-8562

B.A., Villanova University, 1975
M.A., Fairleigh Dickinson University, 1977
Ph.D., Texas Tech University, 1982

Primary Research Interests:

Relationship between human behavior and technology in organizations, specifically, the effects of information system technology on behavior; pursuing methods for improving human use of information resources.

Current Research:

8. Computer-supported meetings;
9. Human resource issues in MIS;
10. MIS implementation;
11. Decision support systems.

GARY W. DICKSON, Professor--624-0371

B.S., University of Washington, 1960
M.B.A., University of Washington, 1962
Ph.D., University of Washington, 1965

Primary Research Interests:

Group decision support systems; management of graphics; IS management.

Current Research:

12. Group decision support systems;
13. Managerial graphics;
14. IS evaluation.

GORDON C. EVEREST, Associate Professor--624-0854

B. Comm., University of Alberta, 1962
S.M., Massachusetts Institute of Technology, 1965
Ph.D., University of Pennsylvania, 1974

Primary Research Interests:

Database management systems; database design and definition; micro computers and the professional workstation; legal aspects of computing, information architecture and CASE tools.

Current Research:

15. The role of the database administrator; organizing for data management;
16. The process of logical and physical database design: theory and practice;
17. Legal issues in computing: data privacy, negligence, contracting, protecting proprietary rights;
18. Improving the integrity of computer-based systems: data integrity mechanisms;
19. Overcoming organizational resistance to using advanced systems development tools;
20. DBMS and application development tools on micros and mainframes.

DALE GOODHUE, Assistant Professor--624-9323

B.S., Brown University, 1970
M.S. (2), Carnegie-Mellon University, 1977
Ph.D., Massachusetts Institute of Technology, 1988

Primary Research Interests:

Data management; end-user computing.

Current Research:

21. Data management: case studies on planning approaches, data architectures, and roles and responsibilities for DRM;
22. End-user computing: development of measurement techniques to assess how well needs of users of corporate data are being met.

THOMAS R. HOFFMANN, Professor--624-9865

B.S., University of Wisconsin, 1955
M.S., University of Wisconsin, 1956
Ph.D., University of Wisconsin, 1959

Primary Research Interests:

Computer applications in operations management and decision support systems.

Current Research:

23. Use of microcomputers in decision support;
24. Future development of computer uses in operations management systems.

SALVATORE T. MARCH, Associate Professor--624-2017

B.S., Cornell University, 1972

M.S., Cornell University, 1975

Ph.D., Cornell University, 1978

Primary Research Interests:

Development of automated tools to aid in the design and implementation of database systems; system development methodologies.

Current Research:

25. Development of descriptive models and analytical techniques for database design.

JUSTUS D. NAUMANN, Associate Professor--624-1364

B.A., University of Minnesota, 1971

M.S., University of Minnesota, 1973

Ph.D., University of Minnesota, 1977

Primary Research Interests:

Information systems development; requirements determination; systems design; systems development management; MIS management.

Current Research:

26. Systems representation and modeling in application systems, artificial intelligence, and software engineering;
27. Applications prototyping.

DETMAR W. STRAUB, JR., Assistant Professor--625-1012

B.A., Hobart College, 1965

M.A., C.U.N.Y., 1967

Ph.D., Penn State University, 1970

M.B.A., Gannon University, 1981

D.B.A., Indiana University, 1986

Primary Research Interests:

Control and security in information systems: auditing of EDP systems; use of external data as information resource; GDSS.

Current Research:

28. Information security in the end-user community;
29. Top management perceptions of the computer security function;
30. Integrated information delivery systems;
31. Utilization of GDSS.

JAMES C. WETHERBE, Professor--624-0547

A.D., New Mexico State University, 1970

B.B.A., New Mexico State University, 1971

M.B.A., Texas Tech University, 1974

Ph.D., Texas Tech University, 1976

Primary Research Interests:

MIS management; systems development.

Current Research:

32. End-user computing;
33. MIS planning, heuristic design;
34. System development methodologies;
35. Planning and control for advanced technologies;
36. Advanced office systems;
37. Knowledge worker productivity.

APPENDIX II
Summary of Associate Attendance at MISRC Activities
1987 - 88

Associate Seminars	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	Total
Kick-off 09/30/87	1	0	1	0	2	1	0	5	2	1	1	1	1	0	1	0	1	1	1	0	0	16	0	36
MBA Night 10/21/87	0	0	0	0	0	2	0	0	0	0	1	0	0	0	3	0	2	3	0	3	0	31	0	45
K. Roering 11/6/87	3	0	6	0	1	3	1	3	2	1	0	1	0	2	0	1	0	0	0	2	3	7	1	37
G. Davis 11/12/87	0	0	2	0	0	1	0	0	0	3	0	3	0	0	0	0	0	0	0	0	1	2	0	22
J. Brancheau 11/24/87	5	1	4	1	2	9	1	3	1	5	3	3	1	8	0	2	3	5	1	1	6	8	4	77
J. Bjelland 01/13/88	4	0	7	0	8	9	4	9	3	6	2	8	0	12	3	3	6	0	1	13	4	4	1	107
C. Kemerer 01/22/88	2	1	3	0	1	10	1	5	0	6	3	5	2	5	1	0	0	0	2	4	0	5	2	58
G. DeSanctis 02/04/88	0	0	1	0	4	4	1	3	0	3	0	4	0	2	0	0	0	0	0	5	1	7	6	41
N. Vitalari 02/19/88	0	0	1	0	3	3	1	0	1	2	2	1	3	5	1	0	1	0	2	4	2	6	2	40
J. Wetherbe 03/02/88	8	3	9	0	7	28	15	3	4	27	5	8	8	8	6	1	6	0	7	16	5	12	4	227
Top Mgmt. Panel 03/29/88	8	2	7	3	9	10	5	4	1	6	1	9	2	3	1	1	0	2	4	3	3	7	3	94
AT&T Panel 04/14/88	3	1	6	0	8	8	2	4	1	6	0	8	0	8	1	0	0	3	6	18	0	7	3	93
D. Goodhue 04/29/88	2	2	12	0	2	13	13	2	3	8	3	6	1	5	0	0	1	1	6	8	1	16	4	109
J. Sheth 05/13/88	0	1	3	0	3	3	7	2	0	4	2	6	1	7	5	1	0	1	2	5	4	9	1	67
Year - End 06/16/88	0	1	1	0	1	1	0	0	1	0	1	2	0	0	1	0	1	2	1	1	0	8	1	23
Total	36	12	63	4	51	105	51	43	19	78	24	65	19	65	32	9	21	18	33	83	30	155	69	1076
Other Activities																								
Disc. Groups	0	2	4	1	3	11	2	6	12	5	1	0	3	11	1	0	4	17	1	11	4	18	0	117
Project Teams	1	0	0	0	1	1	1	0	0	3	0	0	0	0	0	1	2	0	0	1	1	0	0	12
EDC Seminars																								
MMA	3	0	0	0	0	1	0	0	0	0	0	0	0	12	0	0	0	0	0	1	0	0	0	17
MEP	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	5
GRAND TOTAL	43	14	67	5	55	118	54	49	31	86	25	65	22	88	24	10	27	35	35	96	36	173	69	1227

APPENDIX III

MIS Quarterly Articles -- 1987-88

Following is a list of all articles published in the *MIS Quarterly* during the 1987-1988 program year. A cumulative subject and author indices is available free of charge upon request.

Volume 11, Number 3 (September 1987)

SIM Award Paper

1. "A Powerful MIS/DSS Developed for a Remote Sawmill Operation," J.B. O'Keefe and P.F. Wade.

Application

2. "System Development Methods--A Comparative Investigation," Mo A. Mahmood.
3. "Instant Quality Control of Large Batch Processing Jobs," Niv Ahituv and Meir Zelek.
4. "Information Centers: The IBM Model vs. Practice," Houston H. Carr.

Theory and Research

5. "Mapping the Intellectual Structure of MIS, 1980-1985: A Co-Citation Analysis," Mary J. Culnan.
6. "Message Equivocality, Media Selection and Manager Performance: Implications for Information Systems," Richard L. Daft, Robert H. Lengel and Linda Klebe Trevino.
7. "The Case Research Strategy in Studies of Information Systems," Izak Benbasat, David K. Goldstein and Melissa Mead.
8. "Information Resource Planning: Overcoming Difficulties in Identifying Top Management's Objectives," Albert L. Lederer and Aubrey L. Mendelow.
9. "The PICO Model for Information Systems Design," Juhani Iivari.

Issues and Opinions

10. "Comments on Bergeron," John Weitzel.

Volume 11, Number 4 (December 1987)

SIM Competition Paper

11. "Planning and Managing a Corporate Network Utility," Wayne A. Hall and Robert E. McCauley.

Application

12. "The Information Center Concept: A Normative Model and a Study of Six Installations," Clinton E. White, Jr. and David P. Christy.
13. "Systems Analysis and Design: Current Practices," Charles R. Necco, Carl L. Gordon and Nancy W. Tsai.
14. "The Impact of Automated Office Systems on Middle Managers and Their Work," Zeeva Millman and Jon Hartwick.

Theory and Research

15. "Process Tracing Methods in Decision Support Systems Research: Exploring the Black Box," Peter Todd and Izak Benbasat.
16. "Price and Value of Decision Support Systems," Dan R. Piepeta and Evan Anderson.
17. "Data Flow and Data Structure Modeling for Database Requirements Determination: A Comparative Study," Robert W. Mantha.

18. "Training End Users: An Exploratory Study," R. Ryan Nelson and Paul H. Cheney.

Issues and Opinions

19. "Interconnect Technology as a Management Challenge," Harold Lorin, Leslie D. Ball, and Gilbert Eloy.

Volume 12, Number 1 (March 1988)

SIM Competition Paper

20. "Airline Management Information System at Arkia Israeli Airlines," Israel Borovits and Seev Neumann.

Application

21. "After the Sale: Leveraging Maintenance with Information Technology," Blake Ives and Michael R. Vitale.
22. "A Company/University Joint Venture to Build a Knowledge-Based System," John R. Weitzel and Kenneth R. Andrews.
23. "Developing Capabilities to Use Information Strategically," H. Russell Johnston and Shelley R. Carrico.
24. "Determinants of Success for Computer Usage in Small Business," William H. DeLone.

Theory and Research

25. "Matching Computer-Based Information Systems with Organizational Structures," Richard Leifer.
26. "Critical Factors in the User Environment: An Experimental Study of Users, Organizations and Tasks," Gayle J. Yaverbaum.
27. "The Effect of User Involvement on System Success: A Contingency Approach," Peter Tait and Iris Vessey.
28. "Restoring a Sense of Control During Implementation: How User Involvement Leads to System Acceptance," Ann-Marie K. Baronas and Meryl Reis Louis.

Issues and Opinions

29. "How Long Will Computers Stay 'Dumb'?" Peter Kugel.
30. "Reply to Comments on Bergeron," Francois Bergeron.

Volume 12, Number 2 (June 1988)

Sim Competition Paper

31. "Measuring Information Systems Performance: Experience With the 'Management by Results' System at Security Pacific Bank," John P. Singleton, Ephraim R. McLean and Edward N. Altman.

Application

32. "Creating Competitive Advantage With Interorganizational Information Systems," H. Russell Johnston and Michael R. Vitale.
33. "Software Maintainability: Perceptions of EDP Professionals," Chai Kim and Stu Weston.
34. "The Value of Strategic IS Planning: Understanding Consistency, Validity, and IS Markets," John C. Henderson and John G. Sifonis.
35. "A Framework for Comparing Information Engineering Methods," Richard D. Hackathorn and Jahangir Karimi.
36. "The Quantification of Decision Support Benefits Within the Context of Value Analysis," Arthur Money, David Tromp and Trevor Wegner.

Theory and Research

37. "Factors Affecting Information Satisfaction in the Context of the Small Business Environment," Ali Reza Montazemi.
38. "The Measurement of End-User Computing Satisfaction," William J. Doll and Gholamreza Torkzadeh.
39. "Computer-Based Support for Group Problem-Finding: An Experimental Investigation," R. Brent Gallupe, Gerardine DeSanctis and Gary W. Dickson.
40. "An Information Systems Keyword Classification Scheme," Henri Barki, Suzanne Rivard, and Jean Talbot.

APPENDIX IV

Index of Accomplishments by Strategic Issues

To reference MISRC accomplishments by strategic and tactical issues, listed below is an index of the accomplishments achieved for each MISRC topic. The activity numbers correspond to each item listed for a specific activity in the text of the Report.

TOPIC AND ACTIVITY	ACTIVITY NUMBER	PAGE
MIS Management		
Seminar Programs	7, 11, 13, 14	3
Research Grants	1, 7, 9, 11, 14, 18	6
Working Papers	8, 12	9
Articles	1, 2, 19, 23, 32, 33, 39	10
Books	4	13
Discussion Groups	1, 2, 7	17
Student Project Teams	1, 3	18
Training Programs	1, 2	20
Current Faculty Research	1, 2, 4, 8, 9, 13, 14, 15, 17, 24, 29	25
<i>MIS Quarterly</i> Articles	8, 10, 11, 19, 21, 23, 24, 30, 31, 32, 33	31
MIS Planning		
Seminar Programs	4, 6, 12	3
Research Grants	5, 11, 21	6
Articles	8, 25, 40	10
Books	4	13
Discussion Groups	6	17
Student Project Teams	5, 7	18
Current Faculty Research	4, 7, 21, 33, 35	25
<i>MIS Quarterly</i> Articles	11, 34	31
Systems Development		
Seminar Programs	7, 10	3
Research Grants	5, 10, 17, 20	6
Working Papers	6, 11	9
Articles	1, 2, 3, 5, 6, 8, 10, 11, 18, 20, 24, 37, 38	10
Books	6, 7, 8	13
Dissertation Research	5	16
Discussion Groups	3, 5, 6	17
Student Project Teams	5, 6, 7, 8	18
Training Programs	3	20
Current Faculty Research	3, 5, 6, 8, 10, 19, 26, 27, 30, 33, 34, 36	25
<i>MIS Quarterly</i> Articles	2, 9, 13, 14, 20, 21, 22, 25, 33, 35	31
Computer Graphics		
Research Grants	1	6
Working Papers	5	9
Current Faculty Research	13	25

Database Management		
Seminar Programs	13	3
Research Grants	3, 14	6
Articles	21	10
Dissertation Research	3	16
Student Project Teams	6	18
Current Faculty Research	15, 16, 18, 20, 21, 25	25
<i>MIS Quarterly</i> Articles	17	31
End-User Computing		
Research Grants	4, 8, 16	6
Working Papers	8, 9	9
Articles	4, 22, 32, 34, 35, 36, 40,	10
Dissertation Research	1, 9	16
Student Project Teams	2	18
Current Faculty Research	5, 6, 22, 28, 32	25
<i>MIS Quarterly</i> Articles	4, 11, 12, 18, 26, 27, 28, 38	31
Decision Support Systems		
Seminar Programs	8	3
Research Grants	12, 13	6
Working Papers	2, 3, 4, 7, 12	9
Articles	12, 13, 14, 15, 16, 17, 18, 19, 20,	
	25, 27, 29	10
Dissertation Research	6, 10	16
Current Faculty Research	11, 12, 23, 31	25
<i>MIS Quarterly</i> Articles	1, 15, 16, 36, 39	31
Organizational and Behavioral Issues of MIS		
Seminar Programs	3, 5, 9, 11	3
Research Grants	2, 5, 6, 8, 13, 19	6
Working Papers	1, 10	9
Articles	22, 23, 26, 28, 30, 31, 37, 41	10
Books	5	13
Dissertation Research	2, 6, 7, 10	16
Discussion Groups	1, 4, 5	17
Student Project Teams	3	18
Current Faculty Research	5, 6, 9, 19, 37	25
<i>MIS Quarterly</i> Articles	3, 6, 14, 22, 25, 26, 29, 31, 37, 38	31
Other Areas of Research		
Seminar Programs	1, 2, 15	3
Research Grants	15	6
Articles	7, 9	10
Books	1, 2, 3, 5	13
Current Faculty Research	7	25
<i>MIS Quarterly</i> Articles	5, 7, 40	31

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10. Dickson, G.W., "The Management Information Systems Research Center at the University Minnesota: A Support Mechanism," *IEEE*, pp. 843-845, January 1989.
11. Interview between N.F. Schneidewind, Professor of MIS, Department of Administrative Science, Naval Postgraduate School, Monterey, California, and the author, 4 April 1989.
12. Interview between G.T. Howard, Professor of Operations Research, Director of Research, Naval Postgraduate School, Monterey, California, and the author, 24 April 1989.

13. Interview between D.R. Whipple, Professor of MIS, Chairman, Department of Administrative Science, Naval Postgraduate School, Monterey, California, and the author, 10 May 1989.
14. Interview between W.J. Haga, Adjunct Professor of MIS, Department of Administrative Science, Naval Postgraduate School, Monterey, California, and the author, 28 February 1989.
15. Interview between D.R. Dolk, Professor of MIS, Associate Chair for Instruction, Department of Administrative Science, Naval Postgraduate School, Monterey, California, and the author, 5 April 1989.
16. Interview between C.R. Jones, Professor of Information and Telecommunications, Chairman, Joint Command, Control and Communications³, Naval Postgraduate School, Monterey, California, and the author, 26 April 1989.
17. Interview between S.S. Liao, Professor of Accounting, Associate Chair for Research, Department of Administrative Science, Naval Postgraduate School, Monterey, California, and the author, 8 May 1989.
18. Naval Postgraduate School, *Catalog: Academic Year 1989*, pp. 4-6, Government Printing Office, Washington, DC, 1988.
19. Department of Administrative Sciences, "Announcement for Faculty Positions in Information Systems," Naval Postgraduate School, Monterey, California, 1989.

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5. Professor B.A. Frew, Code 54 Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5000	1
6. Professor D.R. Dolk, Code 54 Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5000	1
7. Professor T.X. Bui, Code 54 Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5000	1
8. Professor J.G. San Migel, Code 54 Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5000	1

- | | |
|--|---|
| 9. Chief of Naval Operations, OP-945
Director, Information Systems
Washington, D.C. 20350-2000 | 1 |
| 10. Computer Technology Curricular Office, Code 37
Naval Postgraduate School
Monterey, California 93943-5000 | 1 |
| 11. LCDR John F. Feiler
2105 Haydon Court
Brandon, Florida 33511 | 2 |

616-585



Thesis

F2525 Feiler

c.1 The establishment of a
Management Information
Systems research center
at the Naval Postgraduate
School.

Thesis

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c.1 The establishment of a
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at the Naval Postgraduate
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